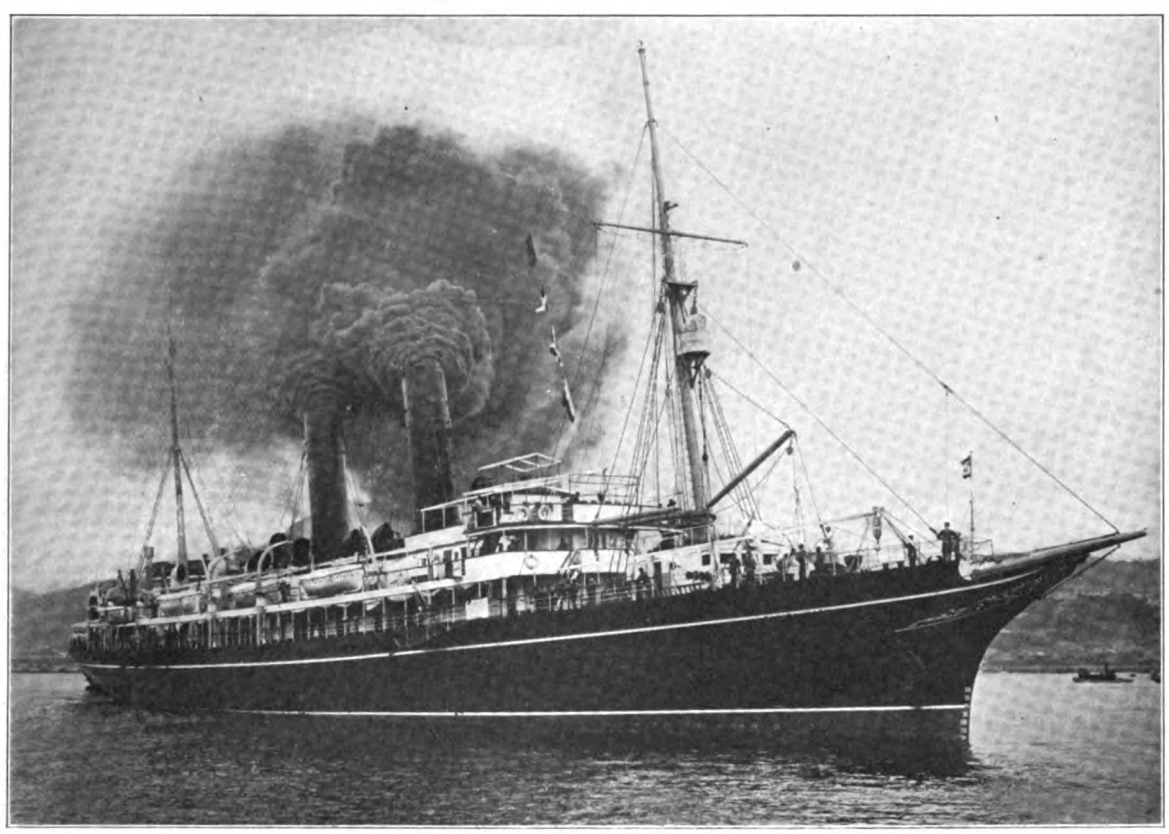
International Marine Engineering

JUNE, 1909.

THE JAPANESE VOLUNTEER STEAMER SAKURA MARU.

The *Sakura Maru,* which was recently completed and is at present on a cruising tour, is unique in many respects, for she is not only the first steamer for the Japanese volunteer fleet, but also the first which is fitted with turbine machinery constructed in Japan. It may be stated here that the Imperial Marine Association, which was founded in 1899, to deal with general maritime affairs, under the patronage of H. I. H. Admiral Prince Arisugawa, saw, during the Russo-Japanese war, the want of merchant vessels which could be fitted out as auxiliary cruisers, and sought the general sympathy of the public to assist the government in providing such vessels.



THE SAKURA MARU, FIRST STEAMER FOR THE JAPANESE VOLUNTEER FLEET.

As a result the Imperial Volunteer Fleet was founded in 1905, strongly supported by the general public, and also by material assistance from Baron Goto, minister of the Communication Department, then the Viceroy of Formosa. The Formosa Vicegerency promised to grant a yearly subsidy of £26,000 ($126,529), on the condition that the first steamer built should run between the mainland and Formosa, and in this connection more than half the fund for the first steamer was raised among the Formosans.

The order for first steamer was placed at the Mitsu-Bishi Dockyard & Engine Works in May, 1906. She was completed in October, 1908, and the management of the vessel was entrusted to Messrs. Osaka Shosen Kaisha, who are to run her as a mail and passenger express steamer between Kobe and Keelun, from the beginning of the year, under the auspices of the Formosan Vicegerency. The general particulars of the vessel are as follows:

Length between perpendiculars	335 ft.
Breadth	43 ft.
Depth	31 ft. 6 ins.
Gross tonnage	3,200 tons.
Draft	17 ft.
Displacement	3,880 tons.
Indicated horsepower	8,500
Speed on trial	21 knots.

Machinery—Parsons marine turbines.
Boilers—Miyabara watertube.

Number of special first class passengers	4
Number of first class passengers	28
Number of second class passengers	42
Number of third class passengers	240

She has a cut-water stem, elliptical stern, two pole masts, with a small signal yard on the fore mast, and two elliptical funnels. As she is a fast boat her lines are very fine, and with her graceful sheer she presents a very smart appearance.

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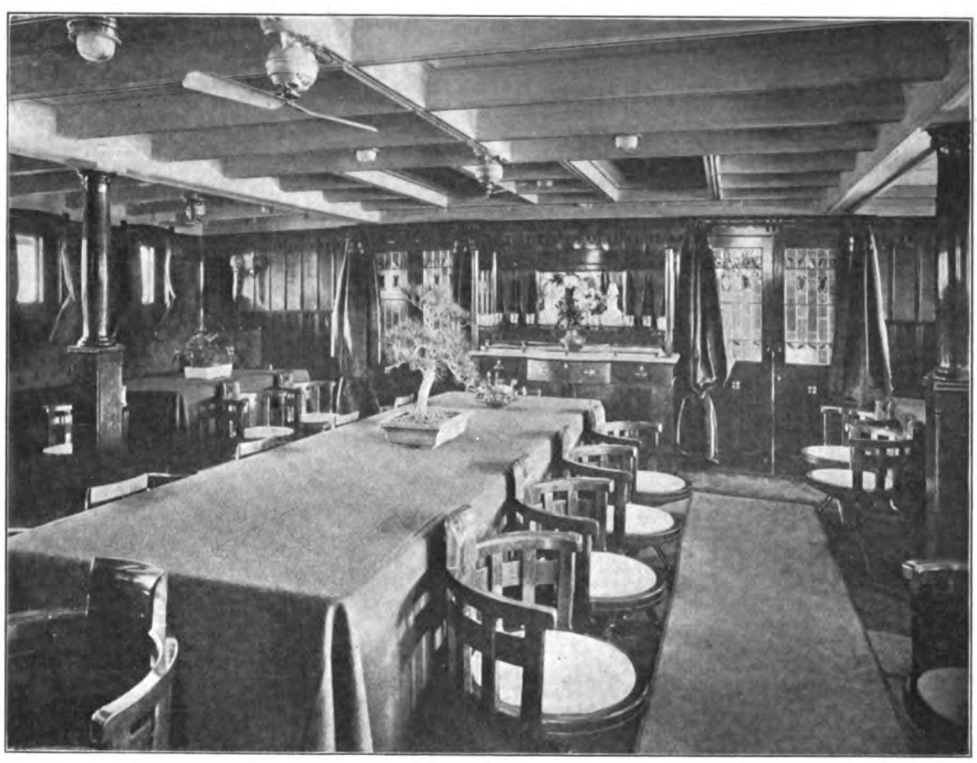
She has been built to meet the requirements of the Japanese Shipbuilding Regulations, and in addition every care and precaution was taken in her construction and fittings to ensure her suitable for use as a merchant steamer in peace and an auxiliary cruiser in war. There are seven watertight bulkheads, which, together with watertight bunker bulkheads, subdivide the vessel into eleven compartments. The main drains are 9 inches in diameter. All the machinery is below the waterline, and watertight coal bunkers are located along the sides of the machinery space. The rudder, steering gear and all communication apparatus and gears are below the waterline. Prevention of fire is effected by dispensing with woodwork as much as possible, and having the main fire-service pipes all below the waterline, with an arrangement so that even if some of the branch pipes which are above the waterline should be destroyed by an enemy, the remaining ones, by means of valves, would probably be ample. Provision is also made to receive two 6-inch guns, six 12-pounders, two 20-inch searchlights, wireless telegraph, magazines, naval boats and many other necessaries in case of need. Bilge keels are fitted for about two-fifths of the length of the vessel amidships.



FIRST CLASS DINING SALOON.

GENERAL ARRANGEMENT.

There are four decks—the boat, shelter, spar and main decks. The boat deck extends about 180 feet amidships, forming a splendid promenade for passengers. At the fore end of the boat deck there is a large deckhouse to accommodate the navigating officers, also with one special room for the special first class passengers. The roof of this deckhouse forms a spacious flying bridge, upon which have been placed the chart room, the bridge being used exclusively for navigating purposes. On the boat deck six 26-foot lifeboats are carried, four of which have Welin's patent quadrant davits. They are also fitted with shifting chocks, permitting the boats to be chocked either fully inboard or along the extreme edge of the deck, thereby saving promenade space. Other boats are fitted with extra heavy davits to receive the naval launches when required. Two other boats are stowed on the after boat deck on top of the after deckhouse. There is also a searchlight platform on the after boat deck.

At the forward end of the shelter deck there is a small deckhouse, which not only contains a companion way and lamp room but serves as a shelter for two cargo winches. About amidships there is a large deckhouse, containing the reading room, first class dining saloon, smoking room and several private cabins. At the center of this deckhouse there is an entrance hall leading to the dining saloon, with a grand staircase leading to the staterooms on the deck below. Ample natural light is provided in way of the staircase by means of a large skylight, decorated with stained glass. The sides and ceiling of the entrance hall are finished in the same manner as the dining saloon. On the central wall there is a large teak frame, with a bronze plaque, bearing over 600 names of the principal subscribers to the fleet.

In general the fittings and decorations of all the public rooms are neat and simple in character. The sides of the dining saloon are finished in a framing of teak, with oak panels inlaid with rosewood. The ceiling is of paneled pine, painted dull white. There is seating accommodation for thirty-four persons, arranged at small tables. There is a handsome sideboard of teak frame with oak panels with inlaid work. In addition to the light obtained from the side windows there are four skylights carried up to the flying bridge, thus conveying ample natural light to the saloon. Skylights and swinging doors are all decorated with stained glass. The upholstery is orange-red Japanese silk, giving the room a cozy and comfortable appearance. The floor is parquetted work of teak and oak. All metal work is of classic Japanese bronze.

Adjoining the saloon is the reading room, with walls and ceiling finished in a similar manner to the saloon but with upholstery of pale green, quite in contrast with the warm, orange-red of the saloon.

In the smoking room, the walls and ceiling are finished in a similar manner as the dining saloon, but the upholstery is of reddish-brown. The clerestory roof, with a skylight with stained glass on top, serves to add to the decorative effect

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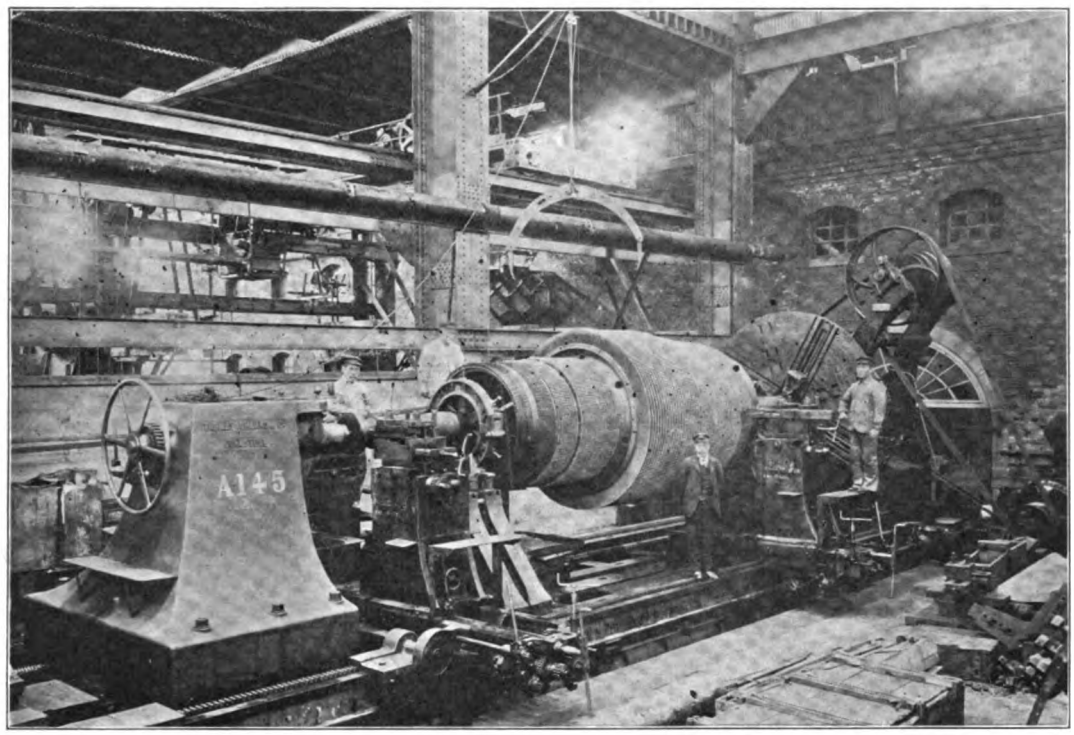
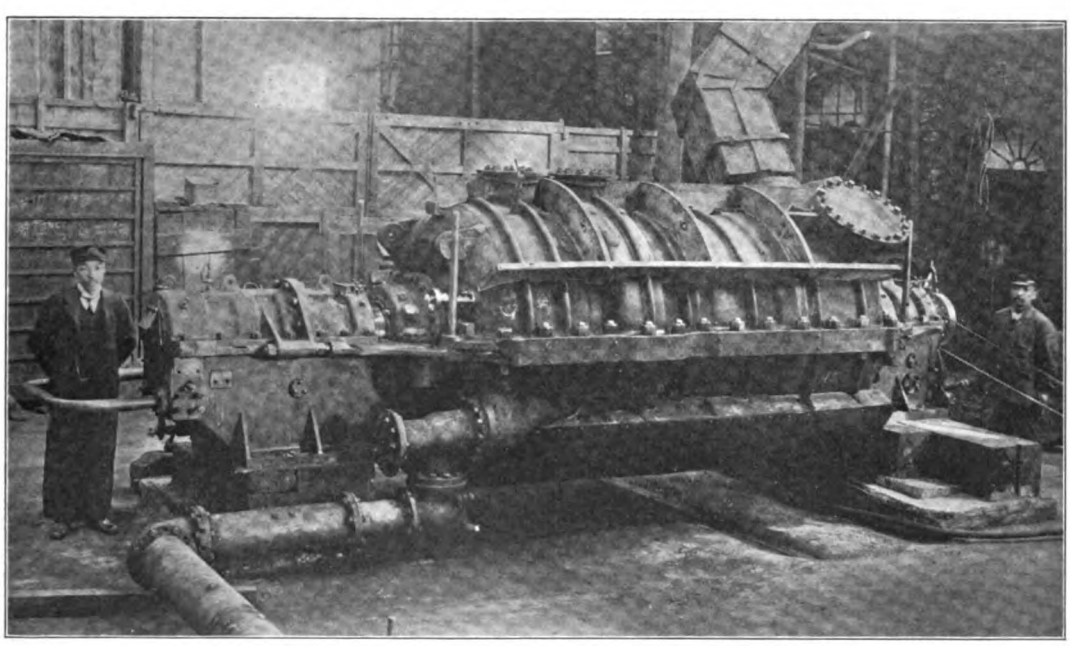


ONE OF THE TURBINE ROTORS, MOUNTED ON A LATHE IN THE BUILDER'S SHOPS.

as well as affording splendid light and ventilation. The floor is covered with inter-locking rubber tiles. At the extreme end of the house there is a barber shop. The remaining space in this deckhouse contains groups of staterooms with convenient baths, lavatories, pantry, bar, etc.

Forward of the engine casing there are commodious accommodations for the chief engineer, and at the after end an upper cold chamber has been provided with connection to one on the deck below, thus facilitating the shipping of provisions to the chambers. A large steel deckhouse is erected on the extreme after end, which is laid off at the fore end as a cargo winch house, with the hospital at the after end, and between these is placed the second class smoking room, with the second class entrance at the fore part. The walls of the smoking room are paneled with dark-colored oak, in bold designs of "rising sun" with carved capitals of cherry blossoms. The ceiling is of paneled pine, painted dull white. Natural overhead light is provided by the large skylights, decorated with stained glass. The upholstery is of yellowish-brown, and the floor is covered with linoleum.



HIGH-PRESSURE TURBINE OF THE SAKURA MARU.

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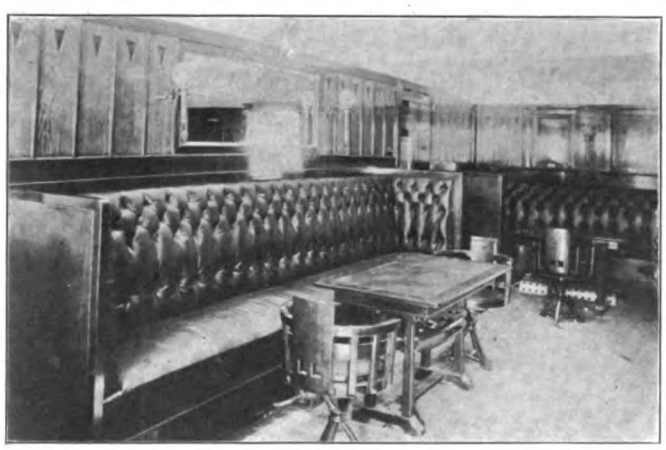
MIYABARA PATENT WATERTUBE BOILERS FOR THE SAKURA MARU.

The spar deck, from stem to stern, is covered, and may be designated the working deck. The petty officers' and third class passengers' accommodations are at the forward end. The extreme after end is devoted entirely to the second class passenger accommodations, with a roomy dining saloon in the center. This saloon, capable of seating twenty-eight persons, is a plain apartment with white-painted steel walls. Groups of cabins are arranged along the entire saloon, and passages. Forward of the grand staircase are eleven staterooms and well-equipped lavoratories. The center portion from the grand staircase aft is taken up with funnel hatches, turbine hatch, cargo hatch, saloon and native galleys; also a large space is devoted to the cold chamber. On the port side the firemen



FIRST CLASS SMOKING ROOM.

have their sleeping and sanitary accommodations; thus they can go about without coming into contact with the passengers. The special feature of this quarter is that the deck is entirely covered with Florbian composition, then laid with chequered steel plates, so that the deck could be kept exceptionally clean. On the starboard side ample accommodations have been provided for engineers, apprentices, cooks and stewards.

The dispensary is also on this deck, abreast the forward funnel casing at the after end of the first class accommodation and adjoining the doctor's room. Special care has been taken to select a spot free from vibration and noise for medical examination, and at the same time one convenient to the passenger accommodations. There is an engineers' mess room adjacent to the dispensary, the floor of which is cemented; thus it may be converted into a sick bay in case of necessity.

For about 145 feet amidships the main deck is given up for the entire breadth of the ship to the turbine room, boiler rooms, coal bunkers, work shop, dynamo and refrigerating machine room. Forward of these there are sailors' and third class stewards' quarters, also third class pantry, the remaining portion of the fore 'tween decks being used entirely for third class passengers. The aft 'tween deck is also fitted out for third class passengers in addition to the large space devoted to the mail rooms and store rooms.

A complete refrigerating plant, supplied by Messrs. J. Hall & Company, is fitted for the preservation of fresh provisions. The plant is capable of producing a large quantity of ice daily.

There is a complete installation of electric light, the power plant consisting of two sets of combined engines and dynamos, of the compound type, either one of which is capable of generating and supplying light equal to about 6,200 candle-power, and of supplying the necessary current for three cluster cargo lamps of 200 candle-power each, and all signal lamps, motors, fans, etc. The current is transmitted by insulated cable of high conductivity, all wiring being done on the double-wire distribution box system. The main switchboards are fitted with ammeters, voltmeter and switch, pilot lamps and switches, double-pole switches and fuses for each of the generators, and change-over switches and double-pole fuses for each of the main circuits. The instruments are of the moving-coil type, and the whole switchboard is arranged for easy handling.

Each compartment has an outlet and inlet ventilator, and these are placed at opposite ends, to produce a continuous current of air. In the third class accommodation the foul air is exhausted by means of powerful electric fans, through trunks led under the beams. Seventeen large overhead electric fans are distributed in the public rooms, and over forty small ball-socket portable fans in the first, second and third class accommodations.

The machinery for working the ship includes a steam windlass supplied by Messrs, Harfield & Company. On the after part of the vessel there is a steam warping capstan with horizontal engines, built by Messrs. Clarke, Chapman & Company. The cargo winches are of the builder's make. The steering gear is by Messrs. Caldwell & Company, the gear being fitted with both telemotor and controlling rods, the former led below the waterline and the latter through the superstructure, and so arranged that when one of them is deranged the other may be readily put into operation. The principal standard is on

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the flying bridge, but there is a second standard on the after part of the boat deck, thus providing means of steering when the principal one is destroyed. The vessel is also provided with an auxiliary telemotor standard, which is to be fitted below the waterline when engaged in naval service. The engine-room telegraphs, steering and docking telegraphs, are supplied by Messrs. J. W. Ray & Company. The engine-room telegraphs are of two independent sets, one being the working and the other the stand-by. There are also Messrs. Chadburn & Son's direction tell-tale and revolution indicators on the flying bridge. In addition to the above the Graham's marine type loud-speaking telephone and speaking tubes, with connection to various important stations, complete the appliances for the transmission of orders from the bridge.

PROPELLING MACHINERY.

The turbine-propelling machinery is of the Parsons type, having the three-shaft arrangement, now usually adopted for merchant steamers, with one high-pressure turbine coupled to the center line of shafting, and one low-pressure ahead and an astern turbine incorporated in the same casing coupled to each wing shaft. Each line of shafting drives one solid Stone's manganese bronze propeller. The turbines of the *Sakura Maru* are the first set designed and manufactured by the builder since they obtained the right for manufacturing the Parsons turbines in Japan, Korea and China. The rotor-wheels are cast steel, the spindles of forged steel of special quality and the casings of cast iron. The blades are of hard drawn brass, and are fixed in the rotors and casings in accordance with Parsons' usual design. The adjusting blocks, which are incorporated in the turbines, are so constructed that they admit of being readily adjusted while the turbines are running. The handles of all starting and maneuvering valves for the ahead and astern turbines are accessible from the starting platform at the forward end of the engine room, and are operated entirely by hand, so that one engineer can have entire control of the whole machinery. With this arrangement the port or starboard turbine is capable of being worked ahead or astern independently of each other and of the high-pressure turbine, the latter rotating idly when maneuvering.

A governor, working in conjunction with a throttle valve, is fitted at the forward end of the turbine bearing. It is driven by worm gear from the rotor spindles. The governor on each shaft is arranged to act independently, and close the throttle valve in the event of the shaft breaking, or the speed of the turbines exceeding the limit at which the governors are set, owing to the propellers racing in a seaway.

Chadburn's patent tachometers and tell-tales are fitted to the forward end of each turbine, and are so arranged that the engineer on watch can, from the starting platform, see not only the direction of rotation of each shaft, but also the number of revolutions of each shaft.

The condensers, two in number, with steel plate shells, are placed in the wings of the ship; Parsons patent augmentor condenser is fitted to each condenser. Water is circulated through the condensers by two independent centrifugal pumps of the builder's make, and there are two sets of Messrs. Weir's twin air pumps of the latest type. Owing to the low temperature of the hot well, consequent upon the attainment of high vacuum, it is becoming more important to consider the economy which may be attained by utilizing the latent heat of the exhaust from the auxiliaries. With this end in view, a surface heater has been fitted, through which the feed water is circulated on its way to the boilers. The feed water is passed through a filter and is then delivered to the boilers by two pairs of Messrs. Weir's double-acting pumps. Each pair of these pumps is capable of supplying the boilers when the turbines are exerting their full power, and so connected that either pair may deal with turbines. Two of Weir's direct-acting pumps are fitted for supplying oil under pressure to the turbines, one for ordinary working and the other for stand-by purposes.

The boilers are arranged in two compartments, each of which has a separate funnel, and in each compartment there are fitted three Miyabara's patent watertube boilers. The boilers work under forced draft, of the closed stokehole system, air being supplied by two fans, each driven by an independent double-acting steam engine. There are two large elliptical funnels. The funnels are double, the spaces between the inner and outer funnels being utilized for ventilating the boiler rooms and stokeholes. The provision for the disposal of the ashes has been made by fitting in each boiler compartment one of See's ash ejectors. One special donkey pump is fitted for working the ejectors. For harbor duty two steam ash-hoisting engines are provided.

AUXILIARY MACHINERY.

The auxiliary machinery includes two large electric engines and dynamos, one of Hall's Company machines, pumps for sanitary purposes, for washing decks, for extinguishing fire and for fresh water for passengers' use. There are also bilge and ballast pumps. The distilling plant consists of two evaporators, together capable of producing from sea water 30 tons of fresh water per twenty-four hours, and two distilling condensers having a combined output of 2,240 gallons of pure, fresh drinking water per day. The engineers' workshop is fitted with a drilling machine, shaping machine, screw-cutting lath, grinder, etc., driven by an electric motor.

SPEED TRIALS.

The full speed trial of the *Sakura Maru* was run on Sept. 26, 1908, over the measured 3.458-nautical mile government course, the results of the six runs being as follows:

Runs.	Speed.
One (down)	21.171
Two (up)	21.390
Three (down)	21.280
Four (up)	21.538
Five (down)	21.316
Six (up)	21.688

It will be seen that the vessel attained a maximum speed of 21.688 knots, the mean of means of the six runs being 21.393 knots, while the guaranteed trial speed was 21 knots.

The construction of the vessel has been under the supervision of Captain-Constructor Dr. Sakurai and Dr. Shin, members of the constructive committee of the Imperial Volunteer Fleet.

TYPES OF WARSHIPS OMITTED IN RECENT PROGRAMMES OF NAVAL CONSTRUCTION.

BY THE RIGHT HON. LORD BRASSEY.

In considering programmes of construction, battleships stand first in order. Those now building for every maritime power are of the *Dreadnought* type. To the British Admiralty belongs the credit of producing the first specimen of the new class of battleship, showing a marked advance over all preceding types in speed and in guns of the heaviest calibre. The coal endurance is sufficient for ocean passages. Occasions may arise in naval warfare when superiority in speed and big-gun armament might decide the issue. It is necessary to secure a preponderance for the British navy in *Dreadnoughts*.

It is not inconsistent to contend that other types beside the *Dreadnought* are of great value for the line of battle. We

* From a paper read before the Institution of Naval Architects, March, 1909.

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see in recent naval construction a continuous increase in dimension and in cost.

	Displacement. Tons.	Cost (Including Guns).
Lord Nelson.....	16,500	£1,654,098 ($8,030,000)
Dreadnought	17,900	£1,813,100 ($8,809,000)
Téméraire	18,600	Not given in navy estimates.
St. Vincent.....	19,250	In round figures possibly
Neptune	20,000	£2,000,000 ($9,733,000).

The latest battleships designed for Germany, United States and Japan are ships of 20,000 tons.

In his recent volume on *Naval Administration*, Captain Mahan insists on the objections to continual increase of dimensions: "When a certain speed has been attained, a small increment must be purchased at a very great sacrifice. What shall the sacrifice be? Gun power? Then your vessel, when she has overtaken her otherwise equal enemy, will be inferior in offensive power. Armor? Then she will be more vulnerable. Something of the coal she would carry? But the expenditure of coal in ever-increasing ratio is a vital factor in your cherished speed. If you can give up none of these things, will you increase the size? * * * Will you have smaller numbers with larger individual power? Then you sacrifice power of combination."

There are considerations in connection with armaments. "The main instrument," says Sir Cyprian Bridge, "is the gun, and it is its fire that has to be concentrated. If the ships are distributed at suitable intervals, the enemy's return fire must be either divergent or be only imperfectly concentrated. * * * The mounting of very heavy armament in single ships reduces numbers. * * * This constitutes an obstacle to the desirable tactical dispersion." So, too, Sir Reginald Custance. In his chapter on the Battle of Tsushima, the gallant author shows how "the fire of sixty-three guns was concentrated on the leading ships of the Russian line. Shells rained on their decks. They were enveloped in a sheet of flame. The great principle of dispersing the guns to concentrate their fire was emphasized and confirmed."

With increase of dimensions we have not secured invulnerability. It is not possible to protect the whole area of side above water with impenetrable armor. In the war in the Far East the mine was a deadly weapon.

If we were creating a new navy for the defence of the British Empire, it would be desirable to lay down a proportion of ships of moderate dimensions. We are relieved of this necessity. We have, as Mr. McKenna has said, a mighty fleet of ships earlier than the *Dreadnought*. The forthcoming volume of the *Naval Annual* will give a list of forty-four British battleships. Classing the *Lord Nelsons* for the time being as *Dreadnoughts*, we have no less than thirty-eight other ships, of which the oldest was launched in 1894. Collectively, these ships carry 144 12-inch guns, eight 10-inch guns, thirty-two 9.2-inch guns, twenty-eight 7.5-inch guns and 428 6-inch quick-firers. They are heavily armored. Speed 18 to 20 knots. With brave and well-trained men behind the guns, and under the command of captains reared in a service which has no record of failure, we have a fleet of vessels which well answer in these later days to the two-deckers of the glorious past.

It is not necessary to dwell on the armored cruisers. The type has disappeared from the latest programmes of construction. Equal in dimensions and in cost, with a slight inferiority in armament and armor, but with a steaming power equal to 25 knots at sea, the four ships of the *Invincible* type and the *Indefatigable* should certainly be included in the *Dreadnought* class in any comparison of naval strength. Armored cruisers cost as much per ton as battleships. Our appropriations to cruiser construction have not been approached under any other naval administration. In the view of many naval authorities it would have been well to have spent less on armored cruisers and more on battleships.

The large protected cruisers are the least effective of all the ships on the British navy list. It is a waste of public money to keep such ships as the *Powerful* and *Terrible* in commission. They carry large crews. They are too vulnerable to be reckoned as fighting ships.

It remains to refer briefly to the inshore squadron. The *Dreadnoughts* are essentially ships for the open seas—beyond the range of the torpedo, and free from the danger of the floating mine. In narrow and shallow waters, in the southern part of the North Sea, with all lightships and buoys removed, navigation would be hazardous in the extreme. At night, and in thick weather, the torpedo would become a most formidable assailant. The gun is a useless weapon against an invisible foe. The naval experience and professional skill which have produced our noble fleets for the open waters should now be directed to the creation of a type specially designed for the inshore squadron.

We are strong in destroyers and submarine boats. The *Monitor*, the armored ram, as designed by Admiral Ammen, U. S. N., and the protected torpedo vessel, as exemplified in our own *Polyphemus*, are types of a past era, but which might still be found effective in modern warfare.

It is hardly possible to close without a reference to pending discussions of to-day. We must look to the future. We must add to the expenditure on construction. We are strong in ships. The amounts voted for Great Britain, Germany and the United States are approximately the same. In Germany one-half, in the United States one-third, in Great Britain one-fourth, of the amount voted for the navy is available for new construction. We cannot keep ahead without further effort.

MARINE PRODUCER GAS POWER.*

BY C. L. STRAUB.

The marine public, who since the days of the Clermont have exclusively associated the term "motive power" with "steam," have every reason for demanding exact and conclusive evidence of the superiority of gas power or any other power, before adopting it in lieu of their present methods. This evidence is only now slowly coming forth. Many who have been credited with authority by the engineering profession and others, either through ignorance or through being misinformed, have beset the way of marine gas power with numberless imaginary obstacles, ridiculous in proportion to the real difficulties, but sufficient, nevertheless, to instill some doubt of the possibilities of the system into the minds of the waiting public.

Only recently has such progress been made in the development of gas power for marine work as to warrant its early adoption in commercial service. Two years ago, less than 300 horsepower in the aggregate was being developed by marine producer gas power installations; these were experimental in nature, and were of the German Capitaine type. There are now installed and accepted twenty-three Capitaine marine plants, aggregating 2,035 horsepower, a partial list of which follows:

a Emil Capitaine, launch, 60 brake-horsepower; four-cylinder, single-acting, four-cycle engine; boat, 60 feet long, 10 feet beam, 4 feet deep; ran an average speed of 10 miles for ten hours on 412 pounds of anthracite coal.

b Rex, seagoing Swedish boat; 102 feet long, 22 feet beam, carries 350 tons on 9-foot draft; fitted with a three-cylinder, single-acting, 45-horsepower engine at 300 revolutions per minute.

* Read at the May, 1909, meeting of the American Society of Mechanical Engineers.

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c Capitaine, towboat at Genoa; length, 47 feet; beam, 12 feet; draft, 7 feet; fitted with a three-cylinder, single-acting, four-cycle engine, 105 brake-horsepower at 240 revolutions per minute.

e Dusseldorf, tug at Hamburg; fitted with a four-cylinder, single-acting, four-cycle engine, 60 brake-horsepower at 240 revolutions per minute.

f Isee, tug; fitted with a three-cylinder, single-acting, four-

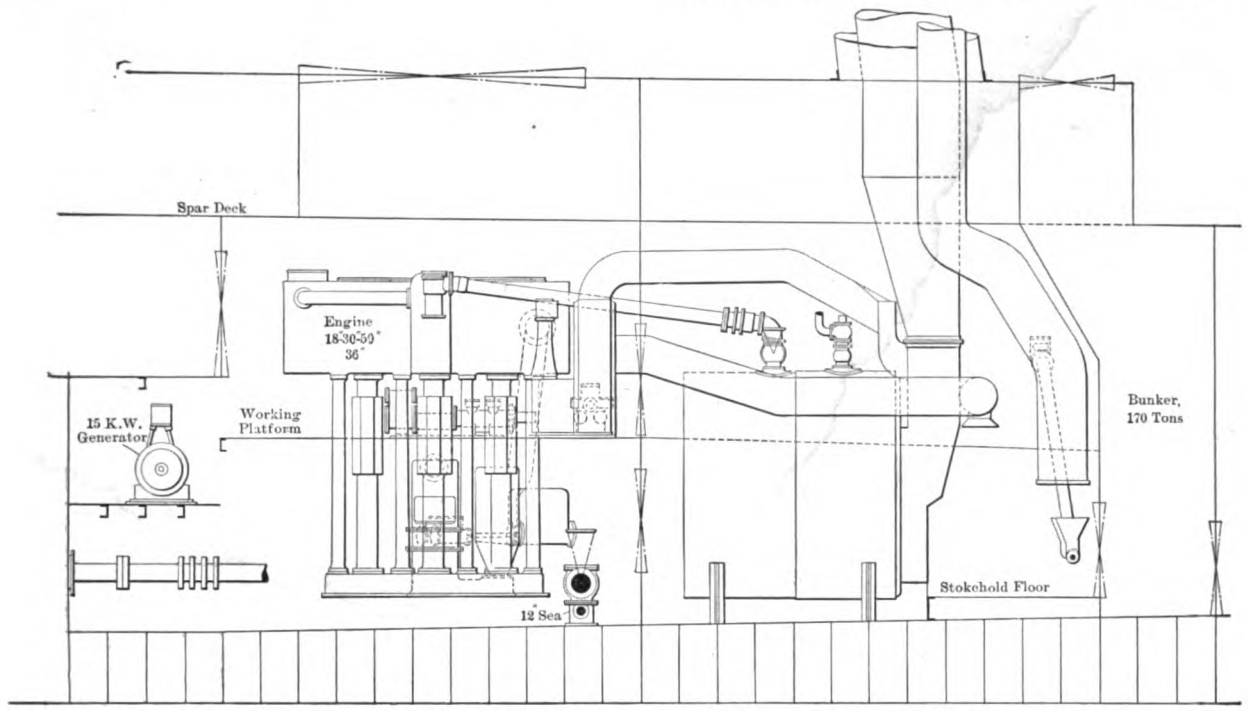

FIG. 1.—ELEVATION OF 1,000 HORSEPOWER STEAM POWER PLANT, NOW INSTALLED IN LAKE FREIGHTER.

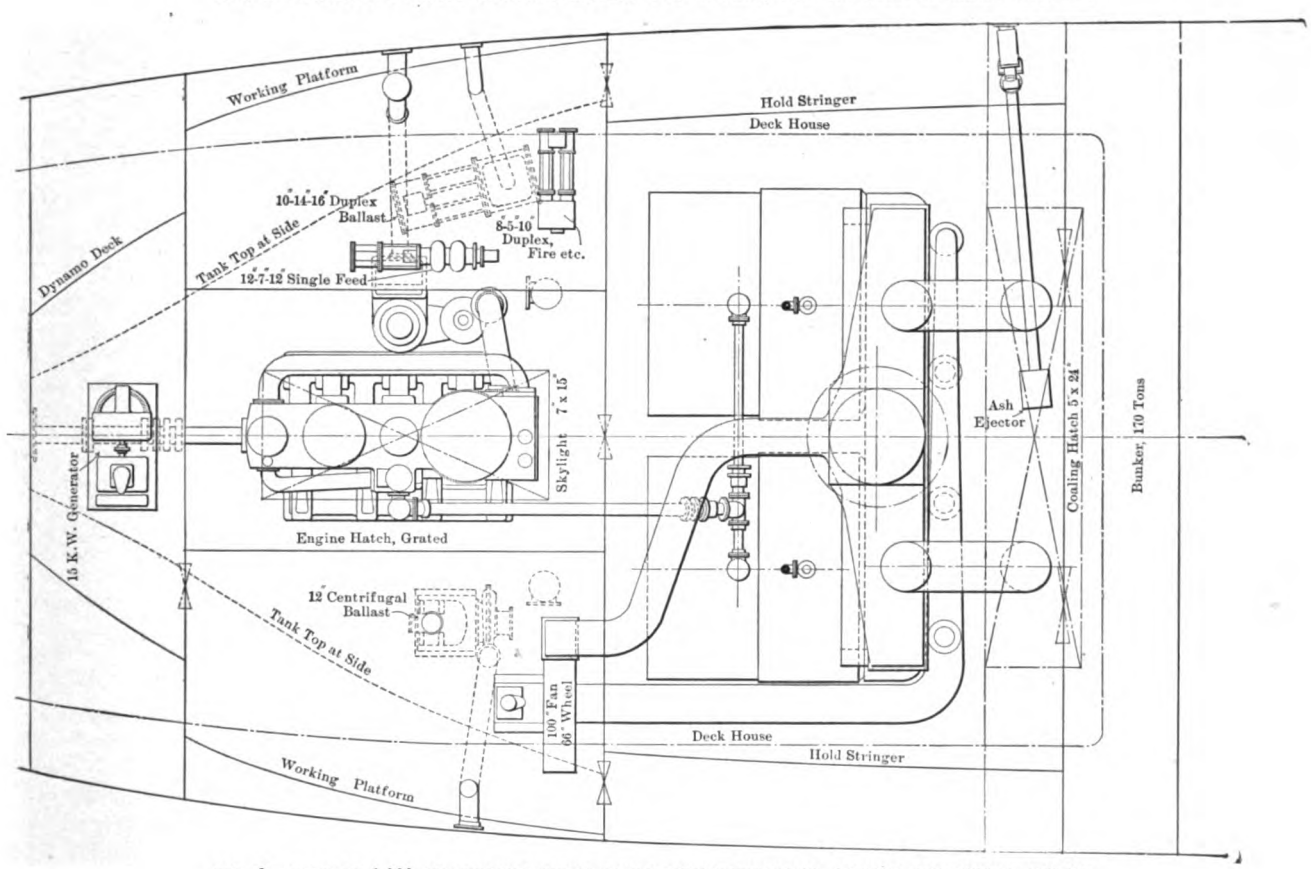

FIG. 2.—PLAN OF 1,000 HORSEPOWER STEAM PLANT; TRIPLE-EXPANSION ENGINE; TWO SCOTCH BOILERS.

d Duchess, canal barge; length, 71 feet; beam, 7 feet 1 inch; carries 20 tons cargo on 42-inch draft; fitted with double cylinder, single-acting, four-cycle engine of 25 brake-horsepower.

cycle engine, 45 brake-horsepower, 300 revolutions per minute.

g Wilhelm, combination freight and passenger Rhine boat; fitted with a five-cylinder, single-acting engine, 175 brake-horsepower at 240 revolutions per minute.

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h Badenia, Rhine freight boat; fitted with a two-cylinder, single-acting, four-cycle engine of 30 brake-horsepower.

i Katrina, canal freight boat; fitted with a three-cylidner, single-acting, four-cycle engine, 45 brake-horsepower.

j Marie, canal freight boat; fitted with a three-cylinder, single-acting, four-cycle engine, 45 brake-horsepower.

k Hoffnung, combination freight and passenger Rhine boat; fitted with a five-cylinder, single-acting, four-cycle engine of 210 brake-horsepower.

l Amersie, Volga freight boat; fitted with a four-cylinder, single-acting, four-cycle engine of 60 brake-horsepower.

m No. 58, canal freight boat; fitted with a four-cylinder, single-acting, four-cycle engine of 60 brake-horsepower.

In addition to the above there were a number of freight boats, the dimensions and names of which we were unable to obtain, but whose power plants varied in capacity from 30 to 175 horsepower each.

n H. M. S. *Rattler,* an old gunboat; 165 feet long, 29 feet beam, originally fitted with a triple-expansion engine. The gas engine is five-cylinder, single-acting, four-cycle. Cylinders, 20 inches diameter by 24-inch stroke, developing 500 brake-horsepower at 120 revolutions per minute. This engine is started by means of a mixture of gas and air, which is pumped into the cylinders at a pressure of about 95 pounds per square inch. This complete plant was designed entirely in the Capitaine Works at Düsseldorf. The total weight of the entire plant, including the donkey boiler for working the pumps and auxiliaries, is 94 tons, as compared with 150 tons in the case of the displaced steam engine. A consumption of 1,525 pounds of coal was made for a measured distance of 45 nautical miles, on an average speed of 10½ knots. The cost per mile for fuel with coal at 15s. 6d. per ton is $0.064. This boat made a maximum speed of 11.3 knots against a 1½-knot current at 110 revolutions per minute of the engine shaft.

All of the above plants by their design and construction are restricted to operation on anthracite coal, coke or hard-burned charcoal, and any plant so restricted by its design to one class of fuel is seriously limited in its scope of application. The development of a simple marine gas producer for use with any class of solid fuel is a necessity, if the system is to be considered seriously by the marine profession. The writer is fortunate in having been associated with some recent American developments both in stationary and marine gas-power plants, a brief survey of a portion of which will enable us to draw more clearly the comparison between a typical steam and a possible gas installation. There are in commercial operation in this country to-day two distinct types of stationary power-gas producers which are suited by their design for operation on almost any class of solid fuel. They may, by their systems

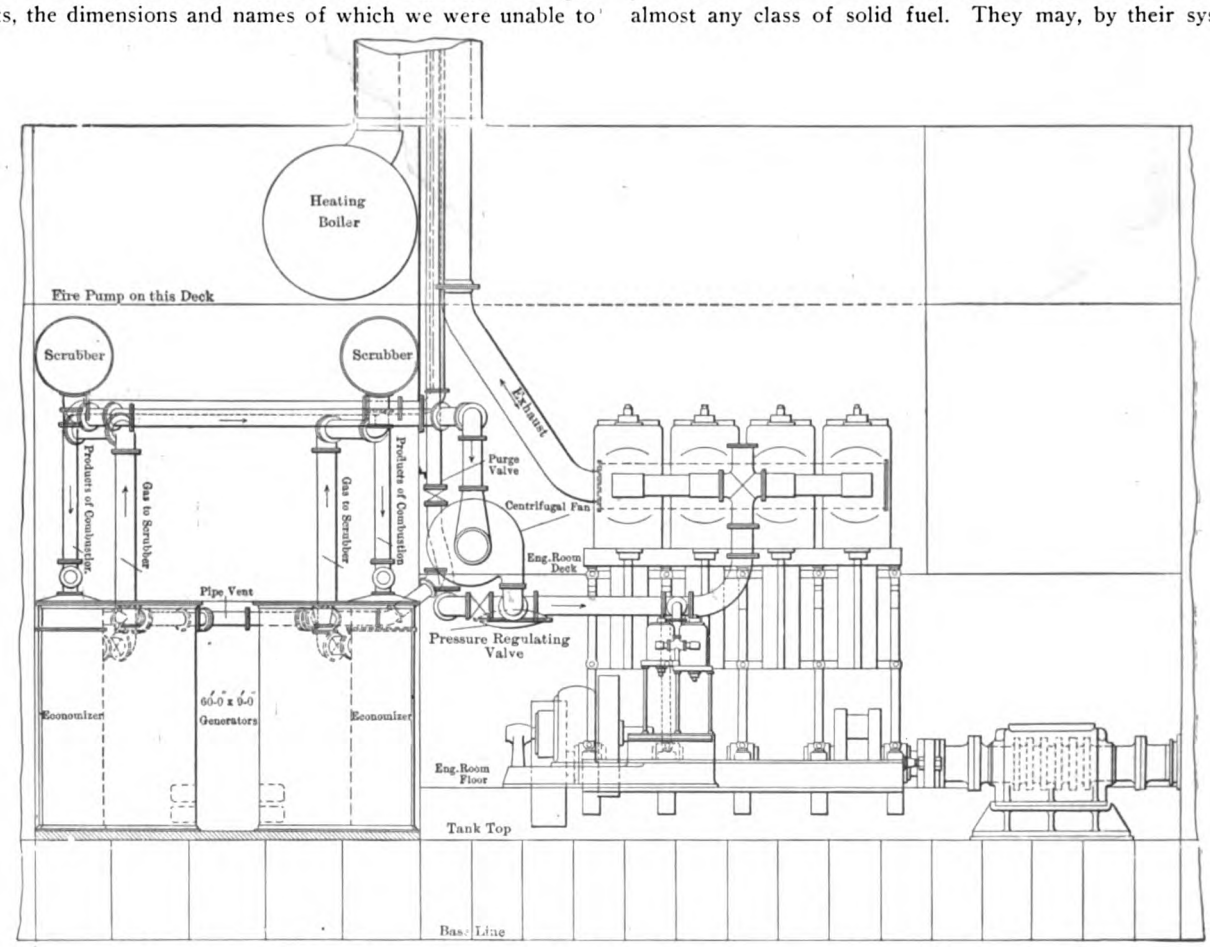

FIG. 3.—ELEVATION OF PROPOSED FOUR-GENERATOR MARINE PRODUCER GAS PLANT; 1,000 HORSEPOWER.

of operation, be qualified as up-draft and down-draft producers.

In the up-draft producer, the fuel is charged into the generator through an air-tight mechanism at the top, while air and steam, or air and products of combustion, are admitted at the bottom of the fuel bed, and passing upward, leave the generator at the top in contact with the fresh fuel. Almost all of the hydrocarbons leave the generator unfixed with the hot gas, only to be condensed later in the gas coolers or scrubbers and gas mains, forming large amounts of tar, which, if not removed to a minute degree, will positively prevent the operation of the engine. The removal of this tar is troublesome, and is accomplished at a loss of power and efficiency. The fuel in the upper zone of the bed in the up-draft producers cokes and cakes so seriously as to require continuous poking of the fuel bed, either mechanically or by hand. These features and others in this type of apparatus contribute to limit the rates of combustion per square foot of grate to a relatively low quantity. All things considered, therefore, this type

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of apparatus has not lent itself agreeably to modification for marine service.

In the down-draft type of apparatus, the fuel is charged by hand through a large door at the top of the producer, which is normally in an open position, allowing the operator unrestricted inspection of the whole upper zone of the fuel bed. The hydrocarbons contained in the fuel are driven off in the upper zone, mixed with air and almost completely burned, and the burnt products, passing downward through the relatively deep bed of fuel, are decomposed and regenerated into carbon-monoxide and hydrogen gases. All of the tar and the lighter hydro-carbons are completely fixed in this process, and

almost 100 percent greater than the average rating of the up-draft type of producers.

Undoubtedly a better method of measuring the ability or success of these two systems is to make note of the number and capacity of plants of each type in actual operation on engine service. A report of the committee on gas engines of the National Electric Light Association, spring of 1908, showed that in gas-engine power plants, of capacities of over 300 horsepower each, there were in operation thirty-two plants of both types having a total capacity of 57,225 horsepower. Of these, four plants were of the up-draft type, having an aggregate capacity of 4,050 horsepower, and twenty-eight plants

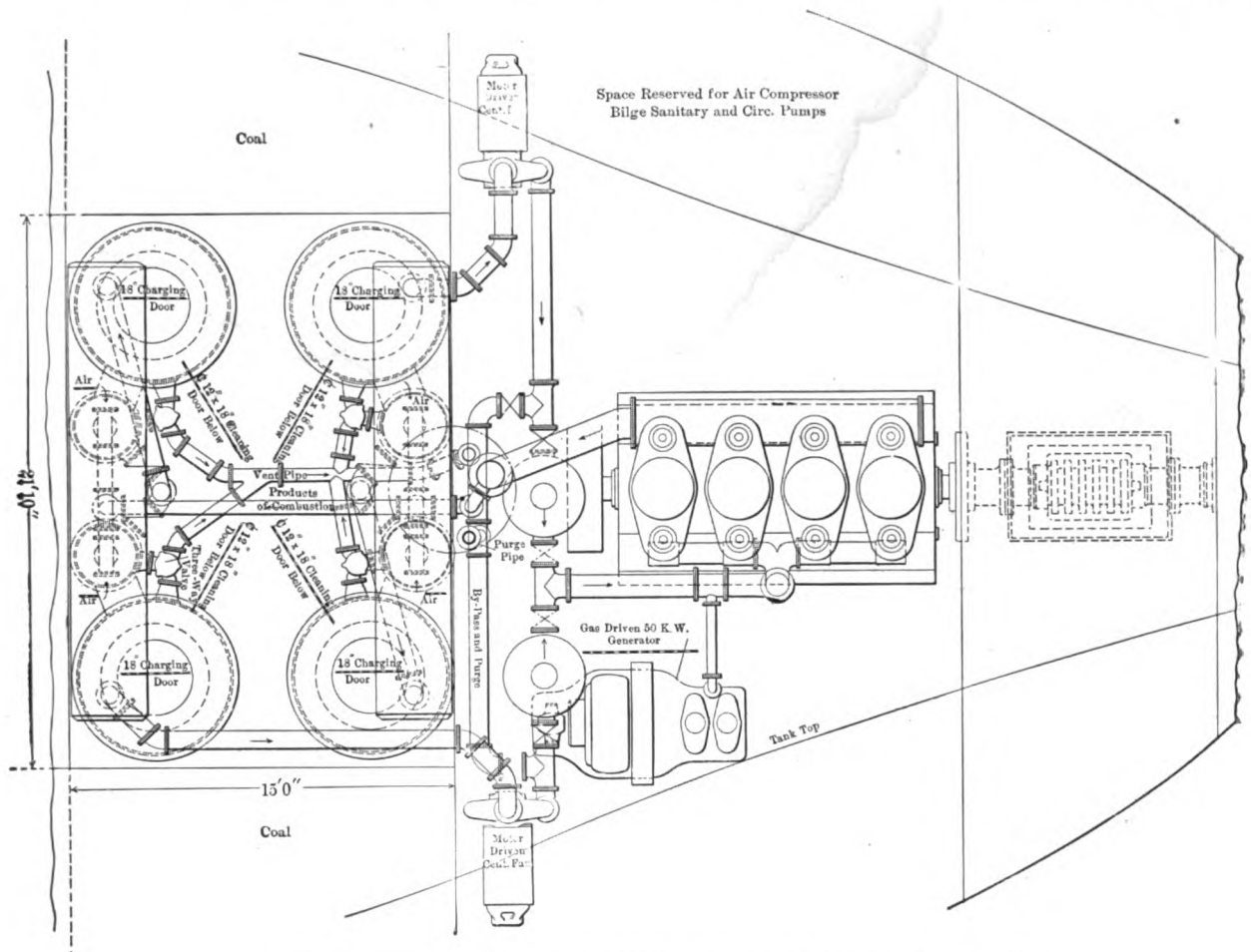

FIG. 4.—PLAN OF PROPOSED FOUR-GENERATOR MARINE PRODUCER GAS PLANT; 1,000 HORSEPOWER.

no tar is found in condensation in any portion of the plant after cooling. Coking or caking of the fuel bed is not detrimental, but, on the other hand, assists in keeping the fire in the open porous condition, which is desirable and necessary where high rates of combustion obtain. This feature eliminates the poking necessary in the up-draft apparatus. The gas leaves the bottom of the producer through brick-lined connections, and a portion of the sensible heat is extracted in passing through an economizer. The gas is then cooled and washed and passed through an exhausting mechanism, whence it is delivered under pressure to the engine.

This type of apparatus lends itself admirably to the high rate of fuel combustion, which for the sake of economy in space and weight is desirable in marine service. There are in actual commercial operation to-day a number of plants of this type having an average fuel consumption of over 40 pounds of good bituminous coal per square foot of grate per hour. These producers are sold on a rating of from 18 pounds to 20 pounds of fuel per square foot of grate per hour, which is

were of the down-draft type, with an aggregate capacity of 53,175 horsepower. The latter contain the Loomis-Pettibone gas generating apparatus, some of which has been in operation on engine service for thirteen years.

Three years have been devoted to the modification of these stationary plants for marine service. The work involved a reduction in the size and weight of the generators; complete revision of the scrubbing, gas-cleansing and exhausting mechanism; elimination of all gas holders, storage receptacles, mixing chambers, etc. The plant as modified to date has a light, compact producer, which, while retaining the same rate of combustion as the stationary apparatus, has materially reduced dimensions and weight of the shell, brick lining, fittings, etc. The economizer boilers which were used on stationary work have been abandoned, and replaced with light air-heating economizers. The gas coolers no longer contain any coke or broken material, or wooden trays, and are built of very light, non-corrosive sheet metal, and arranged for either vertical or horizontal positions, the latter arrangement being convenient

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for space which would be otherwise wasted in the vessel. The cooled and partially cleansed gas is drawn through the above portion of the plant by a centrifugal gas-cleaning exhauster, driven by direct-connected motor. The gas passes directly from the exhauster under pressure, through an automatic pressure-regulating valve, to the engine manifold.

That the plant is adaptable for marine service with regard to space occupied and weight may be seen from the following conservative estimate: Plants of from 100 to 500 horsepower each occupy from 0.4 to 0.5 square foot per horsepower, and weigh from 70 pounds to 90 pounds per horsepower, including all auxiliaries, piping, etc.; plants of from 500 horsepower to 1,000 horsepower, occupying from 0.3 square foot to 0.45 square foot per horsepower, and weigh from 40 pounds to 70 pounds per horsepower, including all auxiliaries, piping, etc.

Undoubtedly the rational opportunity at the present time for marine gas power lies in commercial service, in which regard the most rapid advancement in America has been made in the freight, ore and fuel carriers of the Great Lakes. We have, therefore, taken for our example a ship built from the designs of Messrs. Babcock & Penton within the last year. For the sake of clearness, the views show only the machinery space; all of the ladders, stairways and grates have been omitted from the plans, and the piping is shown only on the gas installation. The machinery installation proper is all there, however, and while the parts eliminated are merely accessory, the contrast between the two plants would be all the more striking were they included.

The boat is a modern lake freighter, and represents the best standard practice in this service. She is 306 feet long over all, 45 feet beam and 24 feet deep. Her present power equipment consists of a single-screw, triple-expansion, three-crank condensing engine, 18, 30, 50 by 36-inch stroke. She indicates 1,050 horsepower at 90 to 95 revolutions per minute. The engine is of the typical box-front columns and condenser back-frame type. She is fitted with direct-connected air pump and has independent steam-driven, reciprocating, circulating, bilge, sanitary and feed pumps. The complete engine-room weight, including piping and all auxiliaries, is, in round figures, 182,000 pounds.

The boiler-room equipment consists of two single-ended Scotch boilers, 11 feet 10 inches mean diameter each, 11 feet length over heads each, operating on a working pressure of 180 pounds per square inch. Each boiler is fitted with two 42-inch corrugated furnaces, and has 244 2¾-inch tubes. The grate surface is 36¾ square feet, and the heating surface 1,642 square feet in each boiler. The boilers are fitted with forced draft from a 66-inch steam-driven fan. The air for the draft is taken from the stokehole, and the fan is located in the engine room. The fan discharge passes through air heaters in the up-take and thence through ducts to the under side of the grates. The complete boiler-room weight, including water in the boilers, but not fuel, is 170,000 pounds. These weights are actual figures.

The coal bunker extends from the main deck to the tank top, and is arranged athwartship. It has a capacity of 170 tons. The bunker doors face the stokers on the stokehole floor. The bunker is 6 feet fore and aft at the stokehole. The distance from the forward to after bulkhead in the boiler room is 24 feet. The distance from the forward to the after bulkhead in the engine room is 22 feet, making a total over-all length for the plant, including bunkers, of 52 feet.

The coal consumption on this vessel is from 1.08 pounds to 2 pounds per indicated horsepower-hour. This coal is approximately 13,500 British thermal units per pound.

The problem of substitution of gas for steam, aside from the design of the construction of the gas producers or cylinders of the gas engines, has been thoroughly worked out by Messrs. Babcock & Penton, of Cleveland. The illustrations show two different arrangements of gas producers with the same engine. The proposed gas engine is a four-cylinder, double-acting, reversing type, having cylinders 24-inch bore by 36-inch stroke, delivering 1,000 brake-horsepower at 100 revolutions per minute. The reversing is accomplished by means of compressed air, which is used to shift the cams from the ahead to the stern position. Compressed air is admitted to the cylinders by timed cams in proper cycle. The crank shaft of the engine is rigidly coupled to the tail shaft of the screw. The illustrations show a column-framed engine. Since making this layout, the design of the engine has been modified to meet all of the present marine conditions now found in marine-engine design on the lakes. In fact, with the exception of the condenser shown on the steam drawings, the gas engine frame will be very similar to the steam engine.

For the generation of current to drive the auxiliaries, there will be installed a double-cylinder, double-acting gas engine, direct connected to a 50-kilowatt direct-current generator. All of the pumps and auxiliaries will be motor-driven. A smaller direct-connected unit, operating on oil, will be used for pumping, blowing fires or other service when the gas plant is down. Allowing a distance of 4 feet 3 inches between the forward bulkhead in the engine room and the forward side of the fly-wheel, which distance is 1 foot greater than that in the steam installation, we have an over-all distance between forward and after bulkheads in the engine room of 19 feet 6 inches.

As previously stated, two arrangements of producer room are shown. The first, the four-generator plant, consists of four 6-foot by 9-foot generators, each fitted with independent economizers. The forward pair and the after pair are connected independently to two horizontal gas scrubbers, which are shown slung under the main deck beams. The gas passes from these scrubbers to independent, motor-driven, centrifugal, gas-cleaning fans, whence it is delivered, either through common connection to a purge or blow-off pipe, which also acts as a by-pass, or through two gas-pressure regulator valves to the air and gas-mixing valve at the engine manifold. The 6-foot generators require only one cleaning door each. As a result, a single cleaning space suffices for the four machines, allowing them to be grouped with reference to athwartship space, so as to give ample room on each side of the vessel for coal bunkers. The total space occupied by the producer plant is 21 feet 10 inches athwartship, and 15 feet between forward and after bulkheads. The producer room weight, including generators, economizers, piping and scrubbers, complete, of the four-generator set, is 110,000 pounds. This weight is estimated, but has been carefully checked and completely covers all the mechanism. In addition to the above mechanism, there will be a heating boiler, which is shown on the main deck. This boiler will serve to furnish low-pressure steam for heating the vessel and supplying hot water for washing down decks, etc. This boiler, with water, will weigh about 8,000 pounds.

The two-generator producer plant, which will undoubtedly be the one installed, will consist of two 8-foot diameter by 9-foot 6-inch generators, connected to independent air economizers and each fitted with an independent horizontal scrubber, located athwartship under the main deck beams. The gas outlet at the scrubbers will be connected with a cross-over, so that either exhauster may operate either or both producer plants. The exhausters are installed in duplicate, and are connected with common purge or blow-off and common gas outlets, leading either through one pressure-regulator valve or through a by-pass direct to the air and gas-mixing valves at the engine manifold.

On account of the fact that the 8-foot generators require two cleaning doors set at 120 degrees, the double-generator unit plant will require the full athwartship space in the producer room. The approximate floor space occupied, therefore, will be 30 feet athwartship and 15 feet between forward and after

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bulkheads. The producer-room weight, including generators, economizers, piping and scrubbers complete for the two-generator set, is 82,000 pounds. This weight is estimated, but has been carefully checked, and completely covers all of the mechanism. As in the case of the four-generator plant, a low-pressure boiler for heating service will be installed. In the two-generator plant, however, this boiler will be located on the producer-operating floor, so that one set of firemen may suffice for both.

The only guide we have for estimating the probable fuel consumption for this service is found in the large number of stationary producer gas power plants now in operation. Fortunately, in marine service, the load factor will be uniformly much higher than that found in any stationary service to which gas power is applied at the present time. The builders of this

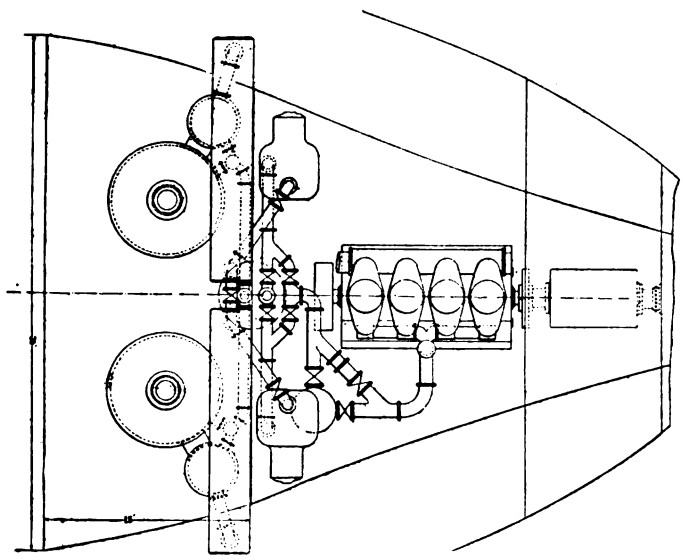

FIG. 5.—PROPOSED TWO-GENERATOR 1,000 HORSEPOWER PLANT.

apparatus are prepared to guarantee 1 brake-horsepower per hour on 1 pound of good bituminous coal, averaging 13,500 British thermal units per pound.

Messrs. Babcock & Penton, the engineers who designed and built the steam plant, and who have spent years on the problem of the substitution of gas for steam, have suggested that the coal bunker, which will be placed above the charging deck of the producer, should have a capacity of about 80 tons of coal. These bunkers will run from the charging deck to the deckhouse, and will have doors opening closely adjacent to the charging doors of the generators, so that little or no coal passing on the operating deck will be required.

In making the comparison shown in the table it is unnecessary to go into the cost of fuel, labor, hours of service, etc., as these elements vary with every class of service. In this particular proposition, it will suffice to state that the engineers who have been working on this substitution problem have conservatively figured that, with the saving in fuel and the increased cargo carried, the cost of the complete plant will be saved in two years of operation.

While the gas plant here described has neither been constructed nor ordered at this writing, its forthcoming will not be long delayed, and this comparison, while somewhat premature, is made to present the possibilities of marine producer-gas power to those interested in its future.

A marine bituminous gas plant, similar in construction and operation to the one described, but of 300-horsepower capacity, has been in commercial operation, driving a six-cylinder, single-acting, reversing marine gas engine for over a year. The results obtained give ample security for the statements made in this paper, and point to the early adoption of this type of prime mover for our marine commercial service.

COMPARISON OF STEAM AND GAS POWER PLANTS FOR GREAT LAKES FREIGHT CARRIER.

Length over all.....306 ft. 0 in.
Beam ..... 45 ft. 0 in.
Depth ..... 24 ft. 0 in.

Displacement .....Tons gross.
Cargo..4,200 net lb., 18 ft. draft.
Speed, 12 statute miles per hour on 900 i.h.p.

STEAM.	GAS.
ENGINE ROOM.	ENGINE ROOM.
3-cylinder triple-expansion, condensing, 18-30-50 by 36 in., 1,050 i.h.p. at 90 to 95 r.p.m.	4-cylinder, 4-cycle, double-acting, gas engine, 24-in. diam., by 36-in. stroke. 1,000 b.h.p. at 95 r.p.m.
Auxiliaries, steam-driven.	Auxiliaries, motor-driven.
Length between bulkheads, 22 ft. 0 in.	Length between bulkheads, 19 ft. 6 in.
Engine room weights, including auxiliaries and piping, 182,000 lb.	Engine room weights, 105,000 lbs.
BOILER ROOM.	PRODUCER ROOM.
2 single-ended Scotch boilers fitted with economizers, forced draft. Length, each boiler, overheads 11 ft. 0 in.	Two down-draft gas producers and auxiliaries.
Mean diameter, each, 11 ft. 10 in.	Diameter shell, each generator, 8 ft. 0 in.
Two 42-in. furnaces each.	Inside diameter, lining generator, 6 ft. 8 in.
244 2¾-in. tubes each.	Height shell, each generator, 9 ft. 6 in.
Grate surface, each 36.75 sq. ft.	Grate surface, each generator, 30.67 sq. ft.
Heating surface, each 1,642 sq. ft.	Producer room weights, no water, no fuel, 82,000 lb.
Boiler room weight, water in boilers, no fuel, 170,000 lb.	
Length boiler room 24 ft. 0 in.	Length producer room, includes bunkers, 15 ft. 0 in.
Length boiler room, includes bunkers, 30 ft. 0 in.	Square feet producer room, 450.
Square feet boiler room, including bunkers, 900	Square feet per h.p., 0.45.
Square feet per h.p., 0.9	Square feet producer room with four smaller generators, 330.
	Square feet per h.p., four generators, 0.33.
Bunker capacity, 340,000 lb.	Bunker capacity, 160,000 lb.
Total weight, machinery and fuel, 692,000 lb.	Total weight, machinery and fuel, 347,000 lb.
Total length of machinery space, including bunkers, 52 ft. 0 in.	Total length of machinery space, 34 ft. 6 in.
	Saving in weight, 355,000 lb.
	Saving in fore-and-aft length, 17 ft. 6 in.
	Saving in cubic space 17 ft. 6 in. by 32 ft. beam by 20 ft. high, 11,200 cu. ft.

Some Considerations on the Application of Internal Combustion Engines for Marine Propulsion.*

BY H. C. ANSTEY.

The principal advantages claimed for the internal combustion engine are economy in fuel, weight and space. It is generally conceded that the least economical of internal combustion engines is more economical than the best steam engine, and there are abundant data to substantiate this claim. This factor alone would seem to make it more than probable that the internal combustion engine must play an important part in the future of marine engineering.

On the question of economy of weight and space very little data are available. What little there is is only applicable to small units, and it by no means follows that the results obtained in small units can be applied directly to larger installations. It is to a general consideration of some factors affecting weight and space that the present paper is directed.

Some very remarkable results have been obtained with small petrol (gasoline) engines in respect to power developed on a given weight, but it is to be remembered that this extreme lightness is due principally to two causes, viz.: (1) a high speed of revolution, and (2) the use of special materials of construction. No part of the extreme lightness is due directly

* From a paper read before the Institution of Naval Architects, April, 1909.

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to the engine being of the explosive type. The word "directly" is used advisedly, because, as will be seen presently, there are certain conditions incidental to the internal combustion engine which make higher speeds of revolution possible than are possible or advisable with a reciprocating steam engine of similar size.

To arrive at a proper sense of proportion on the question of weight and space, it is desirable to examine it on broad mechanical principles. Of the factors which together make up the horsepower of an engine, the only one which in an engine of given power may be altered without affecting its weight is the number of revolutions, subject always to the consideration that the inertia forces due to the speed are not such as to require special strength and weight of parts and foundations.

If we suppose the mean pressure for a particular engine to be constant and the product of the remaining three factors (viz.: area of cylinder, stroke and revolutions) constant also, it will follow that any increase in speed of revolution will be accompanied by a reduction in area of cylinder, or in length of stroke, or both; and owing to these reductions a saving in weight will be obtained. For an engine of given power, therefore, increase in speed of revolution is accompanied by a reduction in weight per horsepower, or put conversely, an increase in the horsepower per ton of engine weight. Some years ago the author, in examining a number of machinery weights of H. M. ships, found that the engine weight could be divided into two parts, one proportional to the horsepower and the other proportional to the horsepower divided by the number of revolutions. Taking a mean of weights for all the vessels of the same class, in order to eliminate differences in design, the engine weight could be expressed as

$$\frac{I.\ H.\ P.}{k} + k_1 \frac{I.\ H.\ P.}{N},$$

N being the number of revolutions per minute.

The values obtained for the constants k and k_1 gave a close approximation to the actual weights in several classes of vessels, and it was possible to determine with some degree of certainty what increase in weight would be involved in a new design by lengthening the stroke and decreasing the number of revolutions. As to the first term, it is clear that in a steam engine there are items of weight, such as steam pipes, valves, condensers and many others, which will depend upon the weight of steam passing, and hence directly upon the horsepower. The existence of the second term is accounted for by the reasoning previously given.

As these elementary principles are purely mechanical, and, independent of the fluid employed, the formula given above, with suitable values for the constants depending upon the type of engine, will no doubt apply to any reciprocating engine.

Returning to the factors in the formula for horsepower, if we assume piston area, stroke and number of revolutions to be constant, the power is proportional to the mean pressure. The weight of the engine is, however, proportional to the maximum pressure for which the engine has to be designed, and the horsepower per ton is, therefore, proportional to the ratio, mean to maximum. In considering what this ratio is in a marine steam engine we are faced with the difficulty that the power is divided between several cylinders, each having a different ratio of maximum to mean, but for purposes of comparison we shall probably not be far wrong if we assume that the whole of the expansion is carried out in the low-pressure cylinder which develops the whole power and is credited with the whole of the weight. Under this assumption the maximum pressure will be, say, 250 pounds, and the mean 50 pounds, giving a ratio of maximum to mean of 5. This ratio will vary with the ratio of expansion, and will be generally higher in the merchant service than in naval practice. In internal combustion engines, in spite of variety of type, there is not very great variation in this ratio. In the engine with which the author is best acquainted it is approximately 4. In petrol (gasoline) engines it will be rather less, and in engines using a high compression it will be somewhat more. Taking the ratio as 4, it must be corrected for the cycle employed, and as the internal combustion engine has in most types only one working stroke in four, the ratio must be multiplied by four, and the comparative figures will then be, for the steam engine 5, for the internal combustion engine 16; that is to say, considered from the point of view of pressure alone, the horsepower per ton in an internal combustion engine will be 1/3.2 times that of a steam engine of the same linear dimensions.

There are, however, certain factors to be considered which will make the comparison more favorable to the internal combustion engine. First, the items of weight in a steam engine which are directly proportional to the horsepower account for a fair proportion of the total weight, but in the internal combustion engine the proportion of similar parts will be very much less. Steam pipes and condenser, for example, have a counterpart in the air and exhaust silencers, which are not pressure parts, and may be made a quite inconsiderable part of the total weight. Inlet and exhaust valves also will be lighter, in proportion, than the slide valves of a steam engine. Secondly, the single-acting engine of the trunk type is lighter than a double-acting engine of the same diameter and stroke, as the latter requires additional height and heavier parts, due to the piston rod and cross head; hence the horsepower per ton will be, in a double-acting engine, not quite four times what it will be in an engine of the same linear dimensions working on the four-stroke cycle. Thirdly, the internal combustion engine is capable of a higher continuous speed than a steam engine, for two reasons: (1) lighter parts, and (2) lower mean pressures on the bearings. With regard to (1), the following are some weights of reciprocating parts expressed in pounds per square inch of piston area:

High-pressure steam cylinder, 8 inches diameter	2.95
High-pressure steam cylinder, 33 inches diameter	5.46
High-pressure steam cylinder, 40 inches diameter	7.7
Petrol (gasoline) engine, 4 5/16 inches diameter	0.63
Oil engine, 9¾ inches diameter	1.45
Oil engine, 15 inches diameter	2.2
Gas engine, 24 inches diameter	4.0

With regard to (2), the sizes of journals in internal combustion engines are larger than those of steam engines of the same power, and although the maximum pressures on them may be as high in the one case as in the other, the mean pressure in the internal combustion engine will be much less, as there is only one working stroke in four.

If we assume that the satisfactory working of a bearing depends upon the product of pressure and velocity not exceeding a safe limit, it will follow that the lower the pressure the higher the speed at which the bearing can be run, and this rule will be found to be generally observed when we compare steam and internal combustion engines used for such work on shore, where the design has become standardized to the requirements. For example, a certain 10-horsepower (nominal) steam engine runs at 135 revolutions per minute, while a 20-brake horsepower oil engine, which is capable of doing the same work, runs at 245 revolutions.

Taking the three factors, lighter accessories, lighter parts and higher possible speeds of revolution into consideration, it would appear that the figure 1/3.2, which was arrived at from considerations of maximum and mean pressures alone, can be considerably increased. How much it may be increased is more or less a matter of conjecture, but it will possibly be of the order of 1/1.5 to 1/2.5, so that for engines of the same linear dimensions the horsepower per ton will in the internal

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combustion engine only be one-half that in a steam engine.

So far we have left out of account the question of weight of boilers and their accessories. These will have a counterpart in the gas producers for the gas engine, but have no equivalent in the oil engine. So far as the gas engine is concerned, the weight and space required for producers is largely dependent upon the type of fuel used and the cleaning arrangements necessary to deal with the gas, and this is too large a subject for the present paper. As the weight of boilers is usually about equal to the weight of engines, it follows from the above conclusion that the horsepower per ton will, for the complete installation, be about equal to that of an oil engine of the same linear dimensions as the steam engine. It is possible that there may be some saving, but it appears certain that if the internal combustion engine is to develop on lines parallel to that of the steam engine, that is, with few cylinders, there will be no very great saving, such as has sometimes been imagined by inference from the results obtained with small-sized units, where the speed of revolution is high. The difference in operating condition of large and small units will depend directly upon the speed.

The limit of speed of revolution will generally be determined by the inertia forces, and these have to be considered first as separate forces requiring adequate strength of the individual parts; and, secondly, in combination with a view of making their algebraic sum as nearly zero as possible. With a sufficient number of cylinders complete balance is comparatively easy to obtain, but the individual forces still remain, and must be provided for. It is usual to assume that the inertia forces, expressed in pounds per square inch of piston area, should be less than the compression pressure, in order to avoid shock due to reversal of stress when combustion follows at the end of compression. It is argued that there is no reversal of stress on the idle strokes (suction and exhaust), but this is only true if we neglect the effect of friction of the piston and slackness in the bearings. It is well to remember, when considering the possibility of shock, that the effect of the load suddenly applied is double that of a load steadily applied, and, further, that the calculation for inertia force can only be made on the assumption of uniform angular velocity of the crank, an assumption probably some distance from the truth in any reciprocating engine. The safe rule is to keep the calculated inertia force per square inch of piston as low as practicable, and if we assign a limit to this, which, from present experience, the author would be inclined to put at 100 pounds, we obtain a formula of the following kind:

$$w \times l \times N^2 = \text{constant}$$

where w is weight in pounds of reciprocating parts per square inch of piston area, l is stroke, and N number of revolutions per minute. This may also be written

$$w \times P \times N = \text{constant}$$

where P is the piston speed; from which it follows that, at constant piston speed, the permissible speed of revolution varies inversely as the weight of reciprocating parts per square inch of piston. The permissible speed of revolution can be connected with the diameter of cylinder in the following manner. If we look at the table of weights given above, we find that the reciprocating weights per square inch of piston increase with the diameter ,and are approximately proportional thereto. This is reasonable, for if we take one part, say the base of a piston, for example, its weight will vary as its area and thickness; and as, for equal strength, the thickness will vary as the diameter, the weight will vary as the cube of the diameter; hence per square inch of piston the weight will vary as the diameter. It will be found that similar rules hold good for other reciprocating parts. Hence, if as found above,

$$w \times N = \text{constant, for constant piston speed,}$$

and if w varies as d, the diameter of cylinder, then

$$d \times N = \text{constant;}$$

that is, for a given piston speed the permissible speed of revolution varies inversely as the diameter. It follows, therefore, that a necessary condition of high speed of revolution and higher power per ton of weight is a small diameter of cylinder.

This reasoning is applicable to engines designed for a particular maximum pressure, but it can be extended to varying pressures by considering that the weights per square inch of piston will vary approximately as the pressure. If P_1 be the maximum pressure we may write

$$d \times N \times P_1 = \text{constant;}$$

that is, the higher the maximum pressure the lower the permissible speed of revolution with a given diameter of cylinder.

This relationship may be called a mechanical law of comparison, and may be applied approximately to determine the relative weights of engines of different dimensions. If we suppose, for example, a petrol (gasoline) engine of, say, 4 inches cylinder diameter and 5 inches stroke and at 1,200 revolutions to give 100 horsepower per ton, and if we take such an engine as a model for one ten times the linear dimensions, the diameter will be 40 inches, the stroke 50 inches, the allowable revolutions will be 120 and the horsepower per ton will be 10.

A modern marine steam engine having these dimensions for its high-pressure cylinder will give (engine weight only) about 20 horsepower per ton, or double the horsepower per ton of the internal combustion engine of the same linear dimensions—a conclusion arrived at previously by a different method of reasoning.

The direction in which light weight is to be sought lies in keeping down the diameter of the cylinder, thus allowing a higher speed of revolution; but for large powers this involves a large number of cylinders. That a larger number of cylinders than usual with steam practice is inevitable is apparent from considerations of uniformity of turning moment, but how far the number can be advisedly increased can only be determined by experience. Up to the present, sixteen cylinders have been used on one shaft, and there seems no reason why this number should not be increased by successive steps of four or more cylinders at each step. The powers, however, which have been obtained per cylinder in engines whose design admits of application to propulsion are not large, probably not exceeding 100 horsepower, and until the unit is largely increased the very large powers required in many present-day vessels are out of reach of the internal combustion engine, the immediate application of which would appear to be concerned mainly in the propulsion of boats and small vessels. In powers, say, of 500 horsepower on one shaft, it appears reasonable to expect 12 to 15 horsepower per ton of machinery weight, and though this is low compared with larger powered engines for naval work, it is higher than the ordinary run of merchant-service practice. The figures given above refer to a complete installation of oil engines, without auxiliaries; the weights will be greater with gas engines, for the reasons already given.

In connection with the use of a large number of cylinders, some reference should be made to the proposals which have been made from time to time for transmitting power from engine to propeller electrically. By this means the total power can be split up into a number of convenient units, and a much larger number of cylinders can be employed than is immediately practicable to place together on one or two shafts with direct coupling to the propellers. The weight of the engine per horsepower is thus kept low, but, on the other hand, the extra weight due to the addition of dynamos and motors to the installation will counteract the saving due to the large number of cylinders of small diameter. There are the further disadvantages of increased cost and higher fuel consumption per shaft horsepower. On the other hand, the system appears to be the only one at present practicable by which the internal

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combustion engine can be applied to the propulsion of vessels requiring several thousand horsepower.

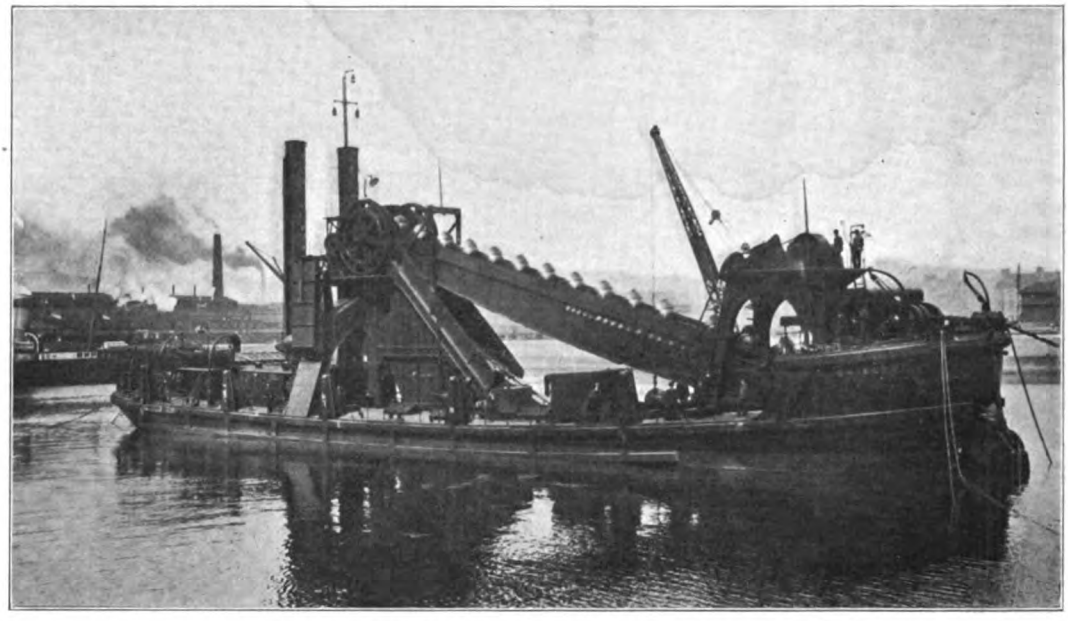
The author has made an approximate estimate of the weight of such an installation for 3,000 horsepower. The total power is supposed to be generated by ten equal-sized electric sets of 300 horsepower, or, say, 200 kilowatts each, running in parallel with one another, and the vessel propelled by three shafts, each fitted with a 1,000-horsepower variable speed reversing motor. The weight of the generating sets would be approximately 240 tons, and the weight of the three motors with bedplates, 43 tons. Switchboards, cables, shafting and propellers would probably require not less than 17 tons, making the total weight about, but not less than, 300 tons; and of this weight, approximately one-third would be due to the electrical portion. This weight is exclusive of auxiliary machinery, the installation of which in a large vessel propelled by internal combustion engines would give rise to a number of problems of some importance, particularly with regard to steering apparatus.

The total floor space required for the generating sets would be about 1,500 square feet, or 2 horsepower per square foot. This is probably somewhat better than the results obtained with steam engines and cylindrical boilers as fitted in the mercantile marine, but it does not compare favorably with the space required for engines and watertube boilers, as used in naval work. The problem of electric propulsion is one of great interest, and its adoption in special circumstances may be justified, but it would seem that generally it does not offer sufficient commercial advantages for mercantile work, and, on the other hand, for naval work it cannot compete with existing steam machinery in the all-important considerations of weight and space. The question of the economical application of the internal combustion engine to propulsion in large sizes, whether the economy is viewed from the standpoint of cost, weight or space, is largely bound up with the problem of making a reliable reversing engine. In small sizes, the familiar devices of reversing propeller or reversing clutch will, no doubt, do all that is required, but few, if any, marine engineers would care to contemplate their adoption in thousands or even several hundreds of horsepower.

An account of a successful experiment in a reversing engine of 80-brake horsepower of the Hornsby type has been given by the author in another place.* The method there described is applicable to larger engines of this type. With such a reversing engine there is a possibility of considerable saving in space over steam machinery, and as compared with mercantile practice, some appreciable saving in weight without reference to saving in quantity of fuel carried.

The main claims, however, which the internal combustion engine has for consideration are in the superior fuel economy and smaller number of men required for working, and these claims are so unquestionable that there appears no reasonable doubt that it must eventually, in a large number of cases, take the place of steam machinery at sea, as it is now doing on land. The author has endeavored to place the question of weight and space required for internal combustion engines in its true perspective, and although the saving, particularly in space, will in most cases be real, he would repeat that, on the whole, there will be no great saving in weight such as has sometimes been imagined by inference from results obtained in small units.

* Proceedings Inst. Civil Engineers, Vol. CLXVIII.



BOW-WELL, CENTER-LADDER, BARGE-LOADING BUCKET DREDGER SHIELDHILL.

THE BUCKET DREDGER SHIELDHILL.

This vessel is the largest and heaviest dredger owned by the Clyde Trust. She was built by Ferguson Bros., Port Glasgow, and is of the bow-well, center-ladder, barge-loading type of the following dimensions: Length, 198 feet; breadth, molded, 39 feet; depth, molded, 13 feet; dredging capacity, 1,000 tons per hour from a depth of 50 feet below the water level.

Separate accommodation is provided below for the captain, engineers, crew and laddermen, fitted up in comfortable style, with a very complete outfit, special provision being made for light and ventilation.

Steam steering gear is fitted at the after end of the engine casing, controlled from the main bridge on top of the main gear framing. This gear has been supplied by Messrs. Alley & McLellan, Glasgow. A complete electric light installation is fitted throughout, large clusters being fitted on deck for night work.

Heavy elm beltings are fitted all round the vessel, also strong, vertical fenders at intervals to take the wear of the barges alongside.

A raised forecastle is formed for the purpose of strongly tying the two sides of the vessel across the ladder well, and the bucket ladder projects sufficiently in advance of the hull to enable the dredger to cut her own flotation. The bucket

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ladder is of sufficient length to dredge to 50 feet, and is suspended in heavy bearings independent of the tumbler. The scantlings are of the heaviest description, and all riveting has been done by hydraulic power. The lower ends of the ladder are specially arranged to take side thrust, and are fitted with connections for oil or grease lubrication, for this purpose pipes being led to pumping apparatus fitted in main engine room.

The framings have been constructed of the best class of girder work of exceptional strength, to withstand the strains when dredging, and riveted with steel rivets closed by hydraulic pressure.

Side shoots are arranged for discharging the dredged material over either side of the vessel into hopper barges, the lifting and lowering of these shoots being worked by a separate, vertical engine, placed amidships, complete with all brakes, barrels, etc.

The two sets of main propelling and dredging engines are of the compound, three-cylinder, three-crank type, using steam at a working pressure of 130 pounds per square inch. The indicated horsepower is 1,100. The auxiliaries include a steam reversing gear, an automatic Weir feed pump, a heater, feed filter, donkey pumps, centrifugal circulating and auxiliary air pumps, in addition to the main engine air pumps. Steam is supplied by two large multi-tubular marine boilers. Telegraphs and speaking tubes are fitted from the various controlling bridges to the engine room, mooring winches and hoisting gear. These have been supplied by Messrs. Wilkinson & Lynch, of Glasgow and Liverpool.

The dredging machinery is of massive design for working in the hardest of materials. The vessel is supplied with two sets of buckets of different capacities, constructed of exceptionally heavy material. The smaller set is intended to be used for dredging material which has been blasted before dredging. The driving gear is of cast steel throughout, the spur wheels being machine cut, and arranged to give a fast and slow speed for soft or hard material, as desired, with the engines running at a constant speed. A large steam crane is fitted on deck for overhauling the buckets and for general purposes.

The hoisting gear for the bucket ladder consists of heavy wire-rope tackle, working in upper and lower sheave blocks suspended from a cross-head fixed on a box-framing structure built into the forward end of the vessel. The lower sheave blocks are connected to the bucket ladder by strong, forged side rods. The wire rope is wound on a large grooved barrel, driven by gearing from a double-cylinder vertical engine, all placed under the deck. The gearing between the engine and barrel is of the sun and planet motion type, controlled by double-friction brakes, actuated with a compound lever for holding, lowering or heaving the load, as desired, the engine being free to run either with or without the load. The wheels and handles for working this gear are placed on deck, under the control of the dredging master. The wire rope is 6½ inches, made of special flexible plow steel.

Powerful steam winches are placed at the bow and stern for manipulating the mooring chains and holding the dredger up to its work. The forward winch has six barrels and the stern winch five. All the clutches are of the Mather & Platt type. Each winch is driven by an independent vertical two-cylinder engine.

Secretary of the Navy Meyer has announced that the voyage of the sixteen American battleships around the world involved an outlay of only $1,500,000 more than would have been necessary had the fleet spent the time occupied on the voyage in home waters, either at anchor or cruising, or engaged in the customary maneuvers. For such a small outlay this is certainly one of the most satisfactory investments that any nation could make.

WATERTIGHT SUBDIVISION.

BY ARTHUR R. LIDDELL.

The loss of the *Republic* has once more called attention to the question of the watertight subdivision of passenger vessels, and again the demand is made for comfortable floating hotels which, while able to cross the ferry in the smallest possible time, can neither be capsized nor sunk. Unfortunately these different qualities do not always agree very well. Comfort means a low metacentric height; that is to say, relatively good chance of capsize when the vessel is rammed amidships. High speed means large spaces for machinery, etc., which do not admit of unlimited subdivision. Again, if the vessel in question has to carry cargo, her holds cannot be unduly reduced in length unless she is to refuse a large proportion of the goods offered to her for transport.

The *Republic* was arranged in the ordinary manner with probably about the degree of subdivision usual for her size. Now, in small vessels it is practically impossible to fit more than the four bulkheads possessed by every tramp. A fifth bulkhead becomes possible in a vessel of about 300 feet in length, and each step of about 50 feet to 70 feet in length, according to size of vessel, enables one more to be added. With the exception of the Germanischer Lloyd, which prescribes limits for the lengths of the various compartments, the Classification Societies in general content themselves with specifying a certain number of bulkheads. It is customary, indeed, in the design of a passenger vessel, to calculate whether she will float with one, or perhaps two compartments flooded, but the loss of the *Republic* has shown once more that subdivision as practiced or practicable does not obviate every danger. The theory of watertight subdivision is that, when one or perhaps two compartments are flooded, the upper deck may, at the lowest point, be just about awash.

Now, assuming that the vessel has sufficient stability in this condition, that her bulkheads hold out, and that the sea is calm, she may have a fair chance of getting to land, or at any rate of keeping above water till help arrives, but if the sea be rough she will be in a very sorry plight. A long vessel floating among waves of her own length will have her deck at the lowest point continually under water. The half height of a wave 800 feet long may be about 20 feet. Such a wave would almost reach the deck of the poop or forecastle of a vessel of the same length, and if the latter sank, say, 10 feet deeper at any part as the result of a collision, the wave would there rise nearly 10 feet above such erection. Whether hatch coamings, deck erections, etc., would then hold out, would be extremely doubtful. Steaming would probably be out of the question. The fact is that most of the precautions invented to allay the fears of timid travelers apply only to fair weather conditions, and to places that are not very far from land, where, after all, most of the collisions occur.

From such accounts as have been published hitherto, it would appear that the flooding of the engine room alone would not have sunk the *Republic*, but that either the after bulkhead of this compartment or the doors in it had not held sufficiently tight. In spite of innumerable closing appliances that are patented or actually applied in practice, bulkhead doors are unfortunately still a weak point. To make quite sure that the vertical sliding doors will be always ready for use and the crew well parcticed in their manipulation, it is customary to institute bulkhead-door drills at more or less short intervals, when the doors are allowed to fall at the word of command and emergency conditions are as far as possible taken account of. The heavy doors fall with very considerable force, and the frequent repetition of this maneuver is apt to jam them so that they are difficult to raise again; it has, indeed, in some cases been known to split the

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frames. To prevent this it is the practice in some vessels to insert wooden chocks across the sills for the doors to fall upon. These also prevent the grooves for the doors being filled with dirt, and they are apt to be left in place, to be removed when a real emergency arises. Now when the green sea comes into the engine room, there is not much time for such removals; the chocks are apt to remain in place and the doors to be let fall upon them. Needless to say the latter do not shut tightly and can no longer be made to do so, even if any one be alive to the cause of the leakage. The leak may in such a case still be kept down, if only pumps are available, and such a vessel as the *Republic* is in this respect well provided. The engineers of this vessel consider that they could, under ordinary conditions, easily have kept her afloat till she got to land, but unfortunately the pumps were in the flooded compartment below the waterline, and neither they nor the engines could be made use of.

There are a good many cases on record in which the engine room of a steamer has been flooded, and it seems worthy of consideration, whether parts of the machinery, such as water-tube boilers, pumps, etc., could not with advantage be arranged on deck, as has at different times been proposed—notably by Herr Leux, of the firm of F. Schichau in Elbing. It has long been a difficulty in the design of a fast steamer to find room for all the boilers, and if the placing of some of them on deck would displace a few passenger berths, the extra safety and other advantages incidental to this arrangement may be looked upon as an important off-set against the accommodation lost. The late Mr. H. H. West, of Liverpool, once proposed to fit passenger accommodations in the holds of vessels. In these days of the electric light, he considered a berth without a window was no longer the unpleasant resort that it used to be. True, a berth with daylight is to be preferred to one without, but many a passenger would gladly put up with good artificial light for perhaps a somewhat lower fare.

The great point is that the public should realize that absolute unsinkability can be obtained only at the expense of all or of most of the advantages for the sake of which a seagoing vessel exists, and that an insistence upon its provision would practically put a stop to ocean traveling. And after all, though the loss of a large passenger steamer is a more sensational and appalling event than, say, a hundred or so railway or carriage accidents, the chances of destruction undergone by a single passenger are probably no greater on the sea than on land.

We are accustomed to hear of the compromise between different qualities represented by the design of a war vessel; this state of things has its exact counterpart in passenger vessels. By all means let us have a collision bulkhead and a reasonable amount of subdivision by well-arranged bulkheads, but do not let us forget that any additional immunity from the various dangers of the sea has to be dearly paid for in money, time, or comfort, or perhaps in all these combined.

The Monaco Race Meet.

The two most interesting events at the sixth annual motor boat exhibition and race meet, held at Monaco in April, were the 50-kilometer race for the Prize of Monte Carlo, and the 100-kilometer race for the "Coupe des Nations." The former event was won by the English boat *Wolseley-Siddeley*, which covered the distance, 50 kilometers (31.07 miles), in 45 minutes and 4/5 seconds, or at an average speed of 38.04 miles an hour. In the "Coupe des Nations," which was over a course 100 kilometers (62.1 miles) long, the *Wolseley-Siddeley* made even better time, winning the race with an average speed of 39.15 miles an hour, and covering one lap of the course at a speed of 40.6 miles an hour.

Practical Experience with the Parsons Marine Steam Turbine on the Ben-My-Chree.*

BY J. C. BLACKBURN.

In respect to size, passenger-carrying capacity and speed, the turbine passenger steamer *Ben-My-Chree*, built by Messrs. Vickers, Sons & Maxim, Ltd., of Barrow, for the Isle of Man Steam Packet Company, represents a marked advance over all channel steamers preceding her. She is 375 feet long, with a breadth of 46 feet, a depth of 18 feet 6 inches, and a designed speed of 24 knots. Accommodations are provided for 2,549 passengers.

The ship is very strongly built to the requirements of Lloyd's and the Board of Trade. The builders have been most successful in the form and arrangements for stiffening the hull aft. The water ballast tanks are carried on each side of the shaft space, and the fore and aft bulkheads shown in Fig. 2, forming the sides of these tanks, provide a very efficient stiffening for the decks, the result being the lessening of vibration. There are eleven watertight compartments, and five of the bulkheads are fitted with watertight doors on the Stone-Lloyd system, which allows of their being closed from the bridge or from below. The ship is capable of floating with any two compartments flooded.

A bow rudder, worked by steam gear, is fitted to facilitate maneuvering operations. For the stern rudder there is a combined steam and hand gear, the steering engine aft being operated by telemotor gear from the bridge.

Very wide alleyways are provided on the decks, with the result that even when carrying the full complement of 2,549 passengers there is ample space for walking about.

THE BOILERS.

There are four double-ended boilers, 16 feet 9 inches diameter, 20 feet 7½ inches long, with eight furnaces, 3 feet 6 inches diameter in each, fitted with common combustion chambers. The working pressure is 170 pounds per square inch. Grate area, 754 square feet; heating surface, 27,446 square feet.

THE TURBINES.

The turbines are arranged on three shafts, the high pressure driving the center shaft and the two low pressure driving the wing shafts. Astern turbines are incorporated in the casing with each low-pressure turbine. The starboard and center propellers are right-handed, and the port left-handed. The diameter of the rotor drum of the high-pressure turbine is 3 feet 11 inches, the low pressure 5 feet 7 inches, and the astern rotor drums 4 feet 2 inches. Each low-pressure turbine exhausts into a separate condenser, the total cooling surface in the two condensers being 14,348 square feet.

The two circulating pumps are of the centrifugal type, each driven by a separate reciprocating engine, the suction and delivery pipes being 23 inches diameter. The air pumps are of the direct-acting twin type, fitted in duplicate for each condenser, the diameter of each pump being 33 inches and the stroke 18 inches. The exhaust steam from the auxiliaries is led into a surface heater by which the temperature of the feed water is raised to 160 degrees.

While on the six hours' trial, the ship maintained an average speed of 24½ knots with ease, and for a portion of the run her speed was 25½ knots. An astern speed of 16.6 knots was attained on the measured mile, and stopping and turning operations were accomplished in a very satisfactory manner. From going 23 knots ahead the ship was brought to rest in a distance of three of her own lengths. It was noticed that the power necessary for propelling the ship astern was about twice that required for going ahead at the same speed.

* From a paper read before the Institution of Naval Architects, April, 1909.

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The general arrangement of the engine room is shown in Fig. 1, and has proved most convenient. Turbine engine rooms are usually extremely hot, but a great improvement in this respect is noticeable in the *Ben-My-Chree*, due to the large hatchway and the efficient lagging of the turbine casings. This lagging is arranged on an improved design, the result being a very small loss of heat by radiation, as shown by the fact that the planished steel covering plates of the high-pressure turbine are no more than blood heat at full power. This result is obtained by supporting the magnesia lagging blocks so as to give an air space of 3 inches to 4 inches between their under surface and the surface of the cylinders. There is an electric fan in each of the forward ventilators in the vicinity of the starting platform, and these largely increase the amount of fresh air entering the engine room.

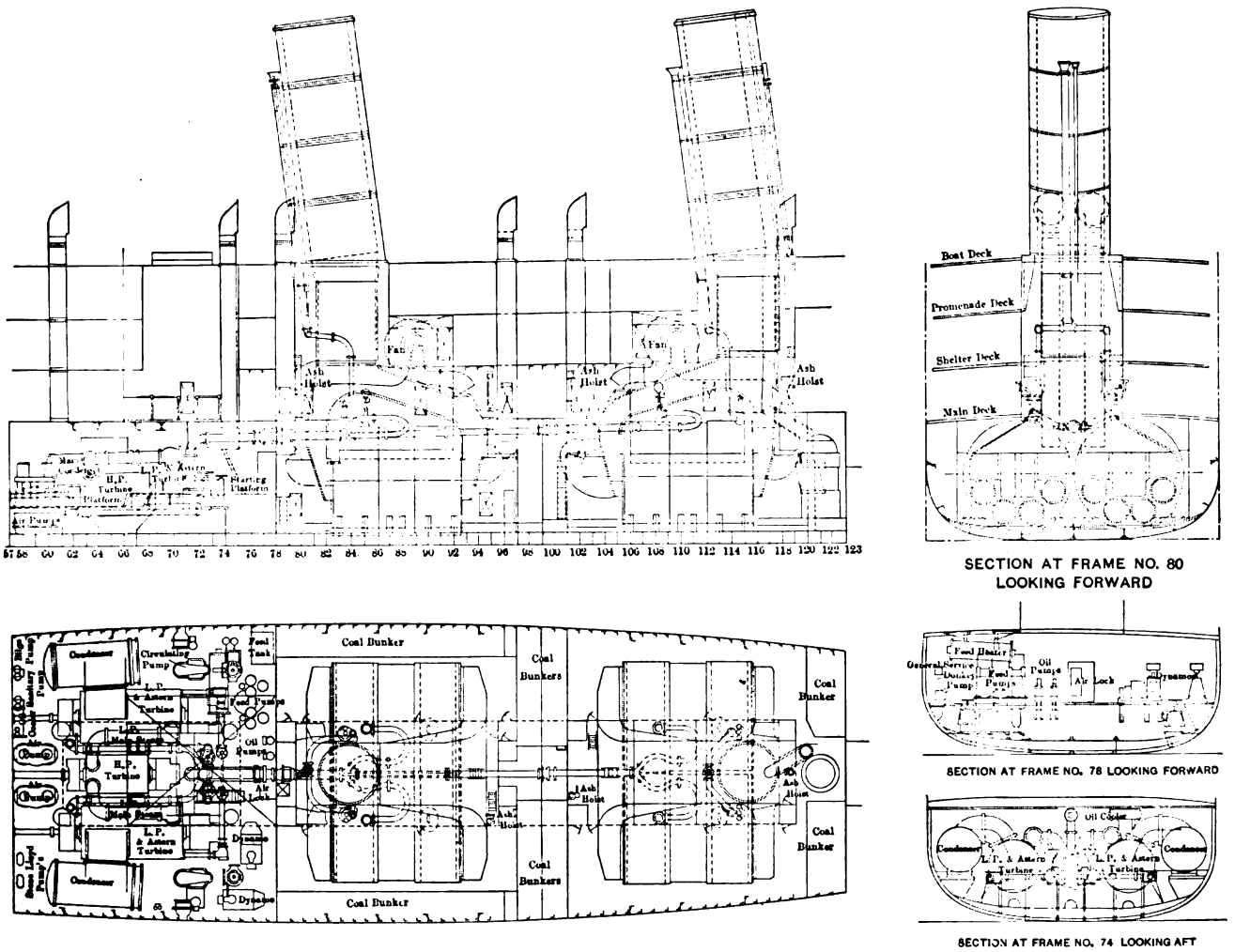

FIG. 1.—MACHINERY ARRANGEMENT OF THE BEN-MY-CHREE.

The propellers are three-bladed, and made specially large to insure good maneuvering powers; they are all three of the same dimensions, viz.: diameter, 7 feet 2 inches; pitch, 6 feet 8 inches.

The work done on service is shown by the extract from the official engine-room log, giving the speed for each run in Table I. The mean speed for ten consecutive runs in deep water between the Liverpool Bar and Douglas Head was 24.12 knots. The speed of all vessels has to be slackened between the Liverpool Bar and the Rock Light while passing dredgers; and the shoal water of the channel, especially at low tide, tends to reduce speed to a very considerable extent. In spite of this, and of the still further reductions of speed on approaching the landing stage, the average for the total distance is 23 knots. The mean draft of the ship during these runs was 13 feet 5 inches, and the displacement 3,353 tons. The mean air pressure in the stokeholds was less than 1 inch water column.

The coal consumption is obtained by dividing the total weight of coal put on board by the number of trips, and includes the coal used each day at Liverpool in going from the stage to anchorage, coal used while at anchor, coaling bars in the morning, making up fires and steaming to the stage. The total of all this has been carefully measured, and amounts to 24 tons per day; this deducted from 95, gives 71 tons consumed per day on two trips, and, as the mean horsepower is 14,700, it works out to 1.87 pounds per horsepower per hour. This consumption, of course, includes the coal used in raising steam for the various culinary purposes on all parts of the ship. Lancashire coal is used throughout.

A noticeable fact is that the number of revolutions is almost identical in the case of each of the three turbines. In looking over the results obtained the following points may be noted:

REGULARITY OF RUNS.

This is due largely to the fact that we had dry steam during the whole of the time. At no period, either during the trials or on service, was there the least indication of the boilers priming. The Isle of Man Steam Packet Company have had a long experience with paddle-wheel steamers, and have adopted an arrangement of corrugated steel anti-priming plates in the new boilers of their ships. These plates are secured to the fore and aft stays of the boilers at the water

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level. Their good effect in preventing priming has been proved beyond doubt. We have adopted a similar arrangement in the boilers of the *Viking* and *Ben-My-Chree*, knowing how liable new boilers are to produce wet steam. I am convinced that to this cause is due much of the credit of the splendid performances of these two vessels. The disadvantages of wet steam are as great in the case of turbines as in reciprocating engines. Wet steam contains initially less internal energy, and the re-evaporation that must take place in the latter stages of the expansions is bound to reduce the useful work which the steam is capable of giving out. The engineer in charge of a steam turbine is very promptly made aware of the fact when priming takes place, and also when steam is wet. The agreeable whistling sound that is an indication to him that all is well has gone, a reduction in the revolutions is soon apparent, and the glands at once indicate the presence of water.

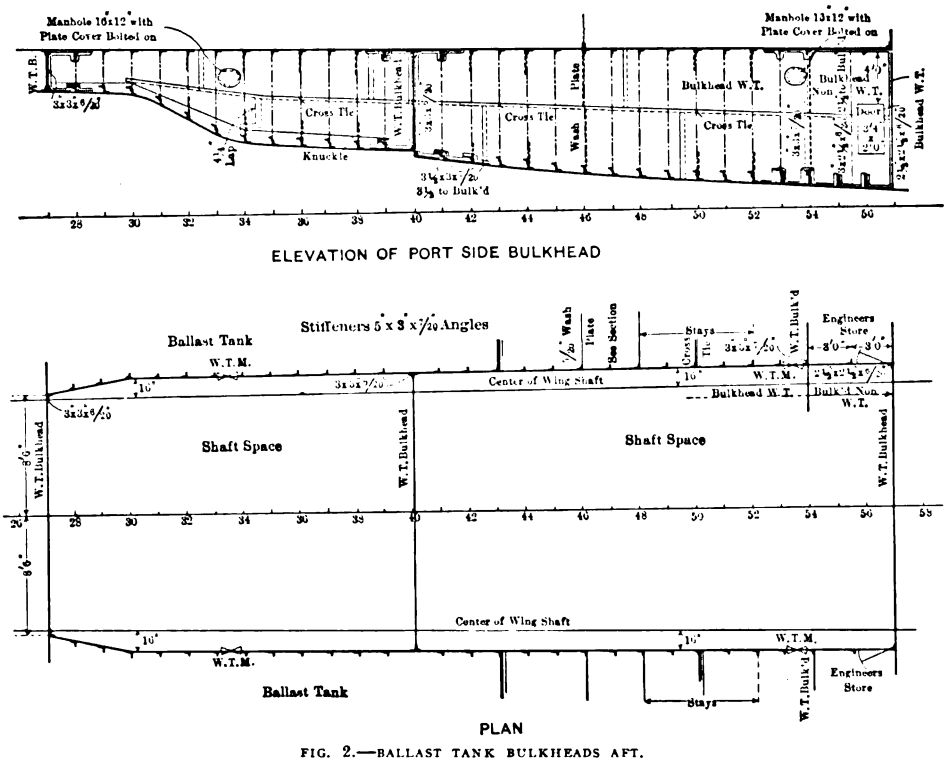

FIG. 2.—BALLAST TANK BULKHEADS AFT.

LUBRICATION.

Very careful attention has been paid to the distribution of oil in the bearings. The pressure in the pipes is 45 pounds. The oil enters the cooler at 126 degrees and leaves at 110 degrees. The cooler is of the surface-condenser type, the oil traversing the tubes four times. The tunnel shaft bearings are 9 inches diameter and 18 inches long, and have water circulation. The lubrication by the usual syphon wool is supplemented by a necklace of plaited lampwick at the fore or high end of the bearing, which revolves with the shaft and dips into an oil bath. No appreciable wear has taken place on any of the turbine bearings, and there has been no heating.

MANEUVERING POWERS OF TURBINE STEAMERS.

Having had experience of the handiness of paddlers, the Isle of Man Steam Packet Company were dubious as to how the turbines would fulfill their requirements in this respect, but the results, I am glad to say, have removed all doubts on this score. The ship has run through the season, taking the piers most satisfactorily, and has not sustained the slightest damage. Taking into consideration the exposed position of Douglas Pier, and the difficulty of berthing at the Liverpool landing stage when the big Atlantic liners are alongside, it speaks well for the maneuvering powers of so large a steamer that she has come through without a scratch. On any day during the season the *Ben-My-Chree* may be seen performing a very expeditious maneuver. The time occupied in backing out with the bow rudder (a distance of about ¼ mile from the pier), in stopping and getting under way until she is again in line with the pier, averages four minutes. This for a vessel of her dimensions could hardly be improved upon by any other method of propulsion.

OVERHAUL.

The *Ben-My-Chree* is well equipped with lifting gear, and the opening up of the turbines for survey has been carried out at a comparatively small cost by the ship's engineers and firemen. The internal condition of the turbines was most satisfactory, the blading throughout being in perfect condition, quite clean and free from any obstructive matter in the spacing. The spliced Ramsbottom gland rings, which had been fitted instead of the ordinary Ramsbottom rings, have proved, along with the radial gland strips, most efficient, and were in perfect condition, with the exception of two rings, which were slightly worn, and which were renewed.

The only parts of the three turbines that showed any defects were the radial dummy strips of the port low-pressure turbine, five out of ten of which were flattened through rubbing against the casing. The reason for this remains a mystery, as the other low-pressure turbine was in perfect condition.

CONDENSERS.

These remained perfectly tight throughout the season, and were tight when tested at the finish. The vacuum averaged 27½ inches, the augmentary condensers contributing on an average 1 inch to this.

With a view to facilitating the testing of turbine steamers' condensers while on service, a distance piece has been introduced between the flange of the exhaust bend and the condenser flange, to which a sectional blank flange can be bolted. The importance of being able to fill the condenser for testing

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T.S.S. "BEN-MY-CHREE." ABSTRACT OF ENGINE-ROOM LOG.
AVERAGES FOR 10 CONSECUTIVE TRIPS ON LIVERPOOL SERVICE, FROM JULY 21 TO 27, 1908.

Date 1908	Sailed. From.	Sailed. To	On Passage. Time.	On Passage. Speed.	Head and Rock. Time.	Head and Rock. Speed.	Head and Bar. Time.	Head and Bar. Speed.	Hours Under Steam.	Pressure of Steam. Boiler.	Main Steam Pipe.	H. P. Receiver.	P. L. P. Receiver.	S. L. P. Receiver.	Vacuum in inches. Port.	Starboard.	Revolutions per Minute. H. P.	P. L. P.	S. L. P.	Coal per trip Tons.
July			hs. mns.	Knots.	hs. mns.	knots.	hs. mns.	knots.												
*21	Douglas	Liverpool	3 6	22.33	2 57	22.80	2 20	24.00	6	165	143	127	18	18	28	27	454	460	460	47½
22	Liverpool	Douglas	3 5	22.46	2 57	22.80	2 22	23.66	6	165	147	137	20	20	27½	27	455	460	455	47½
†22	Douglas	Liverpool	3 1	22.96	2 53	23.32	2 19	24.17	6	165	145	130	18	18	27	26¾	450	455	450	47½
23	Liverpool	Douglas	2 58	23.34	2 53	23.32	2 18	24.34	6	165	150	142	22	21½	27½	27	459	465	463	47½
‡23	Douglas	Liverpool	2 57	23.47	2 50	23.73	2 18	24.34	6	165	147	135	20	20	27½	27	455	460	455	47½
24	Liverpool	Douglas	2 56	23.61	2 51	23.60	2 16	24.71	6	165	145	140	21	21	27¼	27¼	460	465	460	47½
24	Douglas	Liverpool	3 1	22.96	2 53	23.32	2 20	24.00	6	160	145	130	19	19	27	27	457	460	460	47½
§25	Liverpool	Douglas	3 1	22.96	2 53	23.32	2 19	24.17	6	165	152	136	20	20	27½	27⅜	455	460	460	47½
25	Douglas	Liverpool	3 3	22.70	2 54	23.19	2 21	23.83	6	160	143	127	18	18	27¼	27⅛	445	450	445	47½
¶27	Liverpool	Douglas	3 1	22.96	2 53	23.32	2 20	24.00	6	165	148	130	20	20	28	27	450	460	455	47½
Average for 10 Consecutive trips			3 0.9	22.96	2 53.4	23.27	2 19.3	24.12	6	164	146.5	133.4	19.6	19.5	27.5	27	454	459	456	47½

REMARKS.—July 21.—*Going at reduced speed between Bar Ship and Rock Light through low water in channel. July 22.—†Reduced speed between Rock and Bar Ship on both passages, through low water in channel ‡ Record passage to date between Head and Rock. § Delayed off Douglas for 5 mins. through fog. ¶ (26th Sunday.)

DISTANCES:—Douglas Head to Stage..... 69½ nautical miles
Douglas Head to Rock..... 67¼ "
Douglas Head to Bar..... 56 "

COAL CONSUMPTION.

Total consumption for one day.....		95 tons
Coaling bars.....	8½ tons	
Making up fires.....	10½ "	24 "
Consumed at anchor.....	5 "	71
Consumed on single passage (71 ÷ 2).....		35.5 "

COAL CONSUMPTION FOR INDICATED HORSEPOWER.

Horsepower.....	14,700
Revolutions per minute.....	454
Time between Head and Rock (2 hrs. 53.4 mins.).....	2.89 hrs.
Coal consumption between Head and Rock (35.5 tons).....	79,520 lbs.
Coal consumption per horsepower per hour.....	1.87 lbs.

purposes, without filling the low-pressure turbine, will be readily appreciated by those who have had to do with turbine steamers. The condensers must be kept tight, otherwise evils arise; a leaky condenser frequently causing priming.

LYING UP.

As steamers of the class referred to are idle for about six to eight months of the year, it is necessary to take precautions against deterioration during this period. It is advisable to open up the casings as soon after the ship is laid up as possible, then with wire brushes to remove all rust and light scale from the interior of the rotor and casing, to paint these parts with aluminium paint, oil the dummy rings, and close all up again, keeping a heating stove in the engine room during the damp weather.

Speaking after a four years' experience of Parsons' marine steam turbine, from a superintendent engineer's point of view, the small amount of trouble and anxiety involved in the maintenance of this class of engine, as compared with the big paddlers, has astonished me. The turbine steamer gives no trouble whatever. She comes in and goes out, and nothing in the way of repairs is required throughout the season. Take this one item alone—the paddle-steamer *Empress Queen* of 10,000 indicated horsepower, which is still doing excellent work, is propelled by two wheels weighing together about 140 tons, the power being transmitted through two shafts 30 inches diameter. The *Ben-My-Chree* is propelled by three screw propellers of the total weight of 4½ tons, the shafts being 9 inches diameter. The disparity between the weights of the paddle wheels and screw propellers indicates to a very large extent the difference in the trouble and cost of upkeep of the two classes of engines.

In comparing turbine steamers with the ordinary reciprocating twin-screw channel steamers, there are two points in particular which may be noted in favor of the former:

(1) Regularity of speed and economy of fuel in bad weather, the propellers being always well immersed and racing being quite unknown.

(2) Capacity for developing the maximum power at any time without undue strain. The steam turbine responds at once to the increased demand made upon it whenever an extra push is required, whereas when that time comes with a reciprocating engine you have abnormal bearing pressures and choking of steam passages, which absorb a lot of power and causes increased anxiety to those in charge.

Only those who have experienced the stress of managing reciprocating engines when pressed to the utmost limit can fully appreciate the contrast presented by the quiet, steady working of a turbine, and our best thanks are due to the Hon. C. A. Parsons for his worry-saving invention.

The Grab Hopper Dredger North Western.

One of the largest grab-bucket dredgers constructed has been built for the London & North Western Railway Company's service on the Mersey by Ferguson Bros., Port-Glasgow. The molded dimensions are: Length, 200 feet; breadth, 36 feet; depth, 16 feet 6 inches, and the hopper has a capacity for

THE GRAB HOPPER DREDGER NORTH WESTERN.

1,000 tons of material. The vessel is fitted with three crank triple-expansion main engines and two multi-tubular boilers, and an independent condenser. Air and circulating feed pumps are fitted in the engine room. Four powerful steam grabs are fitted over the hopper, capable of loading the vessel in one hour. The hopper doors are maneuvered by steam winches.

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S. S. WAUKETA.

The accompanying plans of the steamship *Wauketa,* of the White Star Line, Detroit, Mich., represent a combination freight and passenger vessel for general service on the Detroit River, between Detroit and Port Huron. The vessel was designed by Prof. H. C. Sadler and Mr. Frank E. Kirby, the general arrangement representing the ideas of Mr. B. W. Parker, general manager of the line. Certain features are of interest.

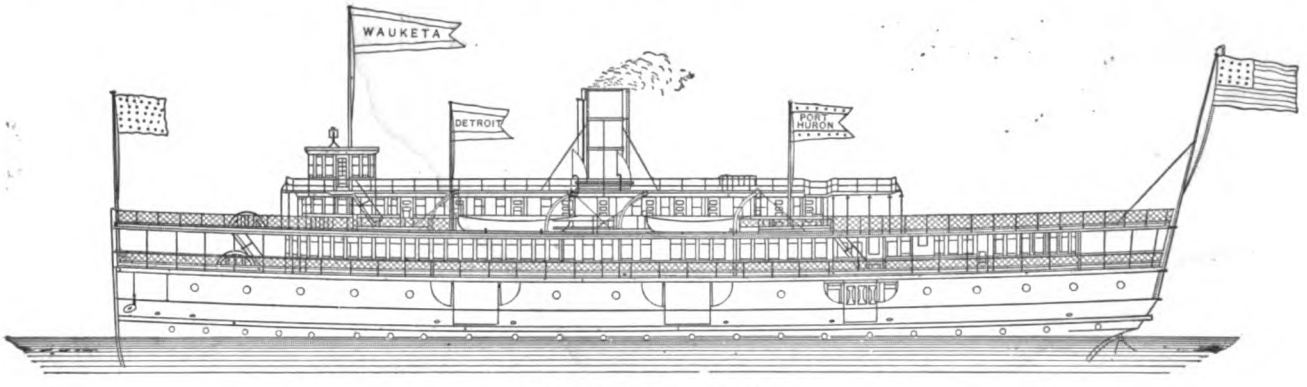
In the first place, the trade is one where a number of stops at different places only a few miles apart are required, and at each place there is a certain amount of package freight to be loaded and unloaded. As this is apt to be somewhat bulky a large deck space is necessary, and this accounts for the somewhat full form of the main deck, and to a certain extent for the adoption of the screw instead of the paddle as a means of propulsion. The freight is loaded on to light trucks, which are wheeled bodily upon the vessel and deposited again at the required port. In this way the handling and time at the various ports is greatly reduced.

The principal dimensions are as follows: Length over all, 185 feet; length on keel, 175 feet; breadth, molded, 38 feet 4 inches; depth, 14 feet. The frame, beams, keelsons and stringers are of bulb-angle section, 5 inches by 2½ inches by 10 pounds, spaced 18 inches at the ends and 24 inches amidships. The shell plating is 10 pounds except the garboard and wale strakes, which are 13 pounds. There are four watertight bulkheads and one partial bulkhead aft of the engine room.

The contract for the steel part of the hull, engines and boilers was let to the Toledo Ship Building Company, and the vessel was delivered in ninety days after the signing of the contract. The actual working time was seventy-six days of nine hours each, and the time from the laying of the keel to the launching was twenty working days, or 180 hours.

The cabins and fittings are being installed by the White Star Line at their own shops.

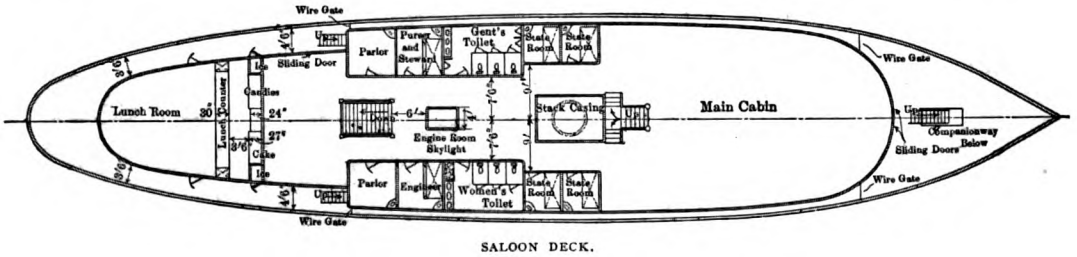
The machinery of the vessel consists of a triple-expansion engine, 17¼ inches, 27½ inches, 43 inches by 30 inches stroke, with the usual jet condenser and necessary bilge, fire and general service pumps. Steam is supplied from three Scotch boilers, natural draft, 10 feet 8 inches in diameter and 11 feet 6 inches long, and at a pressure of 180 pounds per square inch. The vessel will be lighted throughout with electricity and fitted with steam heat.



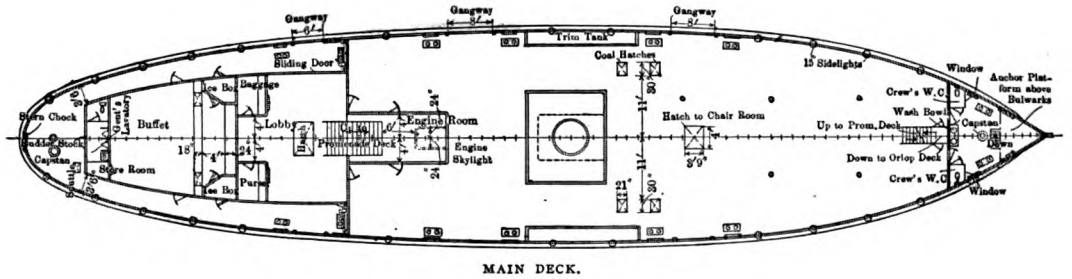
OUTBOARD PROFILE OF S. S. WAUKETA.

The general arrangement of the decks is as follows: On the lower deck forward are accommodations for the crew and galley. The whole of the forward part of the main deck to the after end of the engine casing is reserved for the cargo. The after end of this deck contains the main entrance, offices and bar. The saloon deck is reserved for passengers, and is fitted amidships with a few private staterooms. On this deck there is also a lunch room, with the usual lunch counter. Above this, on the boat deck, are situated the smoking room, the pilot house and the accommodations for the officers.

The model of the vessel was tested in the experimental tank at the University of Michigan, and experiments made until the best form for the given conditions was obtained.



SALOON DECK.



MAIN DECK.

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SOME EXPERIMENTS WITH LIGHTENED BEAM BRACKETS.

BY R. EARLE ANDERSON.

In determining upon the details of certain torpedo-boat destroyers recently designed by the Bureau of Construction and Repair, it was realized that the necessary lightness of structure could be obtained only by giving to each item the most careful consideration, in order that the efficiency of each individual part of the structure, considered from the standpoint of weight and strength, might be made a maximum. Particularly was this the case with such structural members as beam and bulkhead brackets, the frequent recurrence of which throughout the hull made every pound saved in the type of the member a matter of great importance. The bureau had before it, of course, the details of all the torpedo boats and destroyers previously constructed for the United States Navy, and there were used, as a basis for improvement, many of the details of one of these older vessels that had justified in service the excellence of her design. The beam brackets on this vessel consisted of 15 inches by 15 inches by 10-pound lightened plates, without a flange, the type of which, together with the size and distribution of the lightening holes, is shown in Fig. 1. It fell to the writer to improve upon this bracket, the problem being to obtain the strongest and most rigid bracket possible upon the same weight.

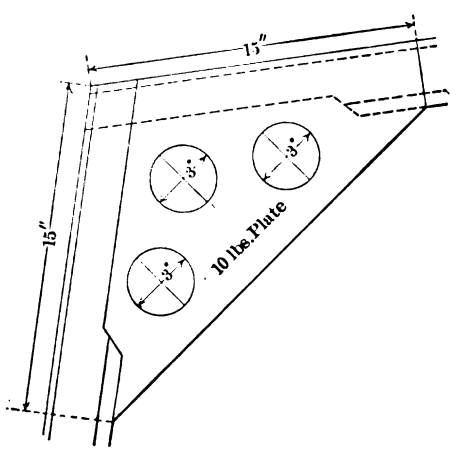

FIG. 1.

It was evident, of course, that a considerable increase in strength and rigidity could be obtained by flanging the edge of the bracket. This meant that if the alloted weight was not to be exceeded, the amount of metal removed by cutting lightening holes must be increased. It was evident also, that a greater area could be cut out by increasing the size of the lightening holes than by increasing their number. A hole 5 inches in diameter was about as large a circular hole as it was practicable to cut in a bracket of this size, however. The effect of such a hole is shown in Fig. 2. The load, that is to say the bending moment tending to open or close the angle between the deck beam and the frame bar, is transferred through the bracket from the rivets in the beam to those in the frame, and the stresses in traveling through the bracket must divide around the lightening hole in some such manner as is indicated in Fig. 2, leaving areas of metal practically unstressed and hence useless, the extent of which can only be guessed at, but which are approximately indicated by the shaded portions of the figure. To cut out these shaded portions would therefore leave the bracket quite as strong as though only the 5-inch hole were cut.

Fig. 3 shows how this theory was applied to obtain the largest practicable lightening hole, and at the same time one that could be cut without an excessive amount of labor. It will be seen that this hole can be cut by using a 5-inch die and a 3-inch die, leaving the small triangular portions to be cut away with a square punch. The amount of metal cut out by using this form of lightening hole made it possible to add to the bracket a tapered flange of the form shown in Fig. 3 without exceeding the allotted weight. In fact, had the bracket shown in Fig. 3 been made of 10-pound plate, as was that shown in Fig. 1, the weights of these two brackets would have been identical.

Some rough comparative tests were made at the bureau which proved the superiority of the flanged bracket with the lozenge-shaped lightening hole, and this form of bracket was thereupon adopted for both deck beams and bulkhead stiffeners. These preliminary tests led the writer to believe that much could be learned about the behavior of parts of structures by tests on small specimens, and he determined upon performing at home a series of such tests on various forms of beam brackets, and the results of these tests confirmed the theory which led to the development of the bracket and the preliminary comparison made at the bureau, and brought about a reduction in the weight of the beam-bracket plating from 10 pounds to 8 pounds.

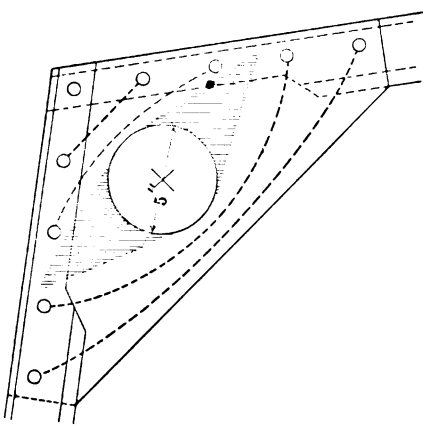

FIG. 2.

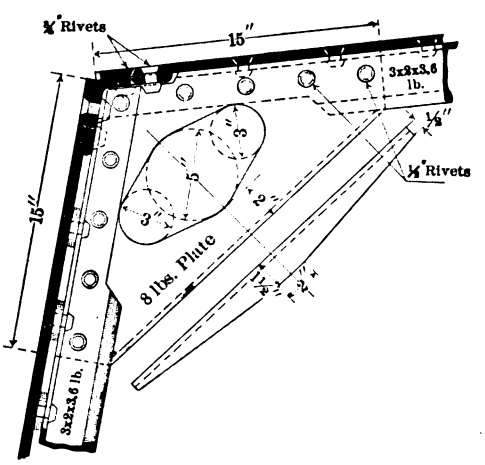

FIG. 3.

It is believed that a description of these tests and of the apparatus used will be not without interest, both because of the actual comparative and quantitative results obtained and because they show that it is possible to obtain much practical information from tests of small specimens, even with the crude apparatus which the home workshop affords.

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The improvised machine used is shown in Figs. 4 and 5. It was built upon the back of a drawing board that was provided with strong oak cleats. A piece of heavy sheet metal (*A*), secured to one of these cleats represented the frame of the ship, while a steel bar (*B*), 2 by 3/16 inch in section, represented the deck beam, the bracket being bolted to these two members and forming the connection between them, except for the bolt (*G*), the function of which will be explained later. To increase the leverage, a second flat bar (*C*) was employed, with a knife-edge fulcrum at *D*, and a link with two knife edges at *E*. The load consisted of two groups of lead batten weights (only one of which is shown in the figure), tied together with wire and suspended on the knife edge *F*. The groups of batten weights weighed, respectively,

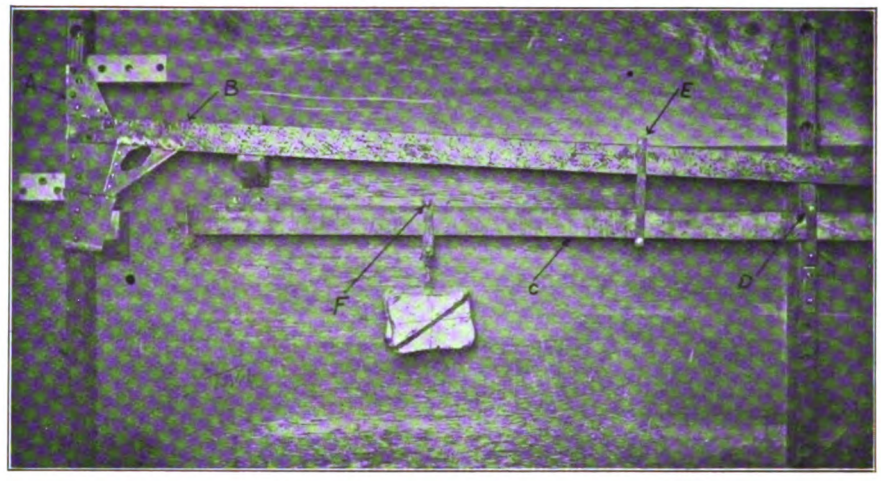

FIG. 4.—TESTING APPARATUS.

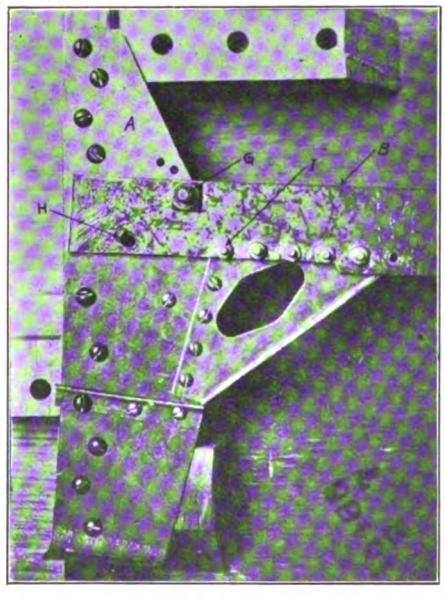

FIG. 5.—DETAILS OF CONNECTION.

19¼ pounds and 19⅛ pounds. The total weight available was thus 38⅜ pounds, to the moment of which was to be added that due to the levers themselves. The total bending moment which could be brought upon the bracket was thus considerable, and in some of the tests was increased by shortening the distance between the knife edges *D* and *E* to about half that shown in Fig. 4. These knife edges consisted of short pieces of steel cut from a ¼-inch square bar and riveted into side pieces of heavy sheet steel. They formed a very simple and satisfactory part of the apparatus and were easily made.

As actually fitted on the ship, the entire connection between the frame and the deck beam does not consist of the bracket only. The deck stringer is, of course, attached to the beam, and the sheer strake to the frame, these two plates being in turn connected to each other by the stringer angle, the riveting of which adds materially to the beam-to-frame connection, and these cannot be neglected in any consideration of the strength of beam brackets. It was necessary, therefore, to so arrange the testing machine as to account for the effect of the stringer angle.

It appeared proper to take account of the rivets in this connection for the extent of one frame space, and as their aggregate area was large in comparison with the area of the rivets connecting the bracket to the beam, it was not practicable to represent them in the testing machine by a bolt of corresponding size and in corresponding location. Accordingly a smaller bolt was used (⅜ inch), and it was placed in such a location that the "neutral axis" of the system of bolts was in a location corresponding approximately to the location of the "neutral axis" of the system of rivets in the actual case. This bolt was originally put at *H*, but after a portion of the tests had been made, it was decided that it would be more nearly correct to locate it at *G*, and this was accordingly done. The comparative results given below were obtained with the "neutral axis bolt" at *H*, while the formulas are derived from the results obtained with this bolt at *G*. In order that the bolts *G* and *I* might not of themselves support the lever and so relieve the bracket, the bolt *I* was put through the bracket and the bar *B* only, the plate *A* being cut out around it.

The test specimens represented the full size brackets to a scale of 3 inches to the foot; that is, they were one-fourth actual size. They were made of sheet steel 1/32 inch thick, corresponding to 5-pound plate. The different types of bracket tested are shown in Figs. 6 and 7. Brackets 1, 4 and 5 all have the same outline, as have also brackets 6, 7 and 10, except that these latter are flanged. Bracket No. 1 is without lightening holes; No. 2 is lightened by ¾-inch holes closely spaced; No. 4 is the same as that shown in Fig. 1; No. 5 is similar to No. 4, but has one 5-inch and two 3-inch lightening holes. These dimensions refer, of course, to the full size bracket, not to the test specimen. Bracket No. 3 is a type which was used on some of the earlier torpedo vessels. It has a flange of parallel width. It forms a brace across from beam to frame, but is hardly a true bracket connection. Nos. 6 and 7 are the same as Fig. 3, except that No. 6 is solid.

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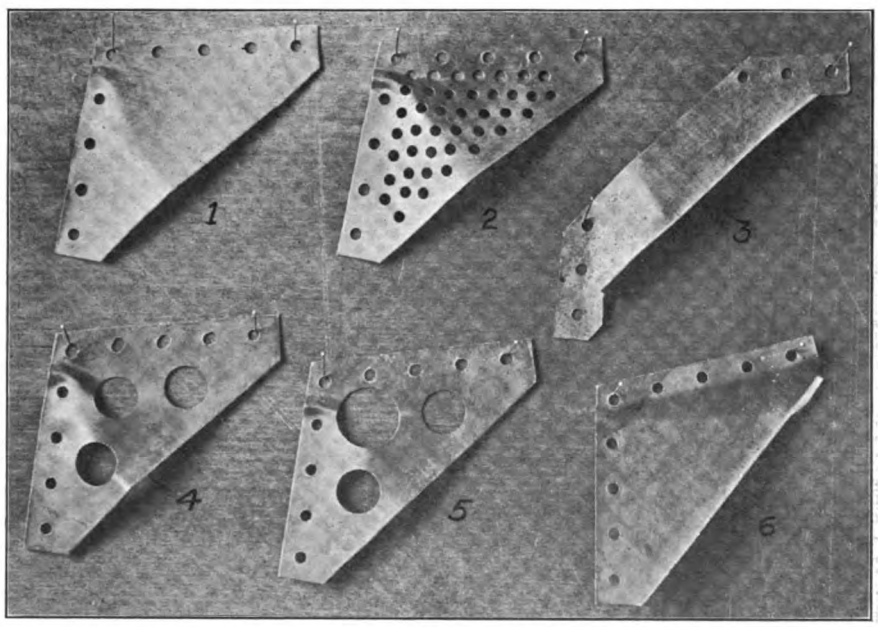

FIG. 6.

Bracket No. 9 is a special type, based on No. 7, but having the extremities of the flanged portion bent down flat and continued to the center line of the bolts, with a view to avoiding the sudden discontinuity of stiffness that occurs in No. 7 where the flange ends.

The results of the tests of twenty-four specimens of types 1, 2, 3, 4, 5, 6, 7 and 9 are shown in the following table.

RESULTS OF TESTS.—SERIES 1.

Type No.	Moment at Failure (in Pounds).	Average Moment at Failure (in Pounds).	Variation Percent.	Weight in Ounces.	Moment Divided by Weight.	Comparative Strength.
1	1,700 1,857 1,395 1,672	1,656	16	1.3	1,274	1.00
2	1,395 1,313 1,337	1,348	3½	1.1	1,225	0.96
3	1,925 1,967 1,823	1,905	4	1.2	1,588	1.25
4	1,407 1,097 1,980	1,495	32½	1.2	1,246	0.96
5	1,305 1,563 1,540	1,469	11	1.1	1,336	1.05
6	2,763 3,020 2,450	2,744	10½	1.5	1,829	1.43
7	2,334 2,334 2,773 2,438	2,470	12	1.2	2,058	1.62
9	3,166	3,166	..	1.2	2,638	2.07

Column 1 refers to the different types as designated in Figs. 6 and 7. Column 2 shows the bending moment that caused failure in the case of each specimen. Column 3 shows the average ultimate bending moment for each type. Column 4 shows the maximum percent of variation of the individual ultimate moments from the average ultimate moment for each type respectively. Column 5 shows the average weight of each type. There is given also for each type a factor obtained by dividing the bending moment at failure by the weight of the specimen. This factor does not, of course, give a true basis of comparison, but as all of the specimens were of nearly the same general dimensions, it provides a reasonably fair means of eliminating the differences in weight and judging the relative value of the different types. Accordingly the last column gives the comparative strength as determined by the moment-weight factor, taking type No. 1 as unity.

Certain important deductions may be made from this table, some of which are of general application to forms of structure other than brackets. A comparison of the strength factors in the last column shows that the strength of types 1, 2, 4 and 5; that is, the brackets without flanges is almost exactly in proportion to their respective weights; that is, in whatever proportion the bracket is lightened, whether by large holes or small, the strength is reduced in the same proportion. In the case of the flanged types 6 and 7, however, the lightening hole makes almost no difference. The average ultimate bending moment is slightly higher for 6 than for 7, but the ranges of values for individual specimens overlap, and the comparative strength with the weight factor eliminated is considerably higher for the lightened bracket than for the solid one. Bracket No. 9, as was expected, is the most efficient of all, but is, unfortunately, not practicable for structural work. Bracket No. 3, while stronger than the unflanged types, shows the lack of a throat connection and is consequently inefficient as compared with type 7, although preferable to 1, 2, 4 and 5.

The column of percent of variation is not without interest. With the exception of type 4, all the variations are within the limits usually obtained for specimens of this general class in thoroughly equipped testing laboratories. The home-made testing machine and the one-fourth size sheet-metal specimens need no defense in view of these results. With respect to the excessive variation in the case of type 4, it simply shows the general unreliability of an excessively lightened, unflanged plate bracket. That the results for type 5 do not show as great variation, may be, and and probably is, due to accident.

Aside from the lack of a flange, the trouble with types 4 and 5 is, that there is a great localized weakness near the edge of the bracket. If an unflanged bracket is to be used, type 2 is certainly preferable to the large hole type for this reason.

What the table does not show is the behavior of the different types under stress and before failure. According to the table, the flanged bracket, type 7, is 62 percent stronger, weight for weight, than bracket No. 1, and 70 percent stronger than the unflanged bracket of equal weight, No. 4. Actually, however, and for the practical purpose for which the brackets are intended, that is for rigidly connecting two structural

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members so that their full strength may be developed, superiority of the flanged bracket over the unflanged one is vastly greater than the figures show. For, while the flanged brackets showed little or no lateral deflection until the breaking load was approached, the unflanged brackets deflected laterally to a decidedly appreciable extent under the least load that could be applied, namely, that of the lever bar *"B"* only, this deflection increasing greatly as the load was increased. In fact one of the most remarkable things noted during these tests was the extent to which these unflanged brackets would deflect laterally before total collapse.

It is thus evident that within the limits of a safe working load, the flanged brackets can be depended on for absolute rigidity, while the unflanged plates are entirely worthless from this standpoint and cannot be depended upon to add anything to the resistance of the vessel against wracking.

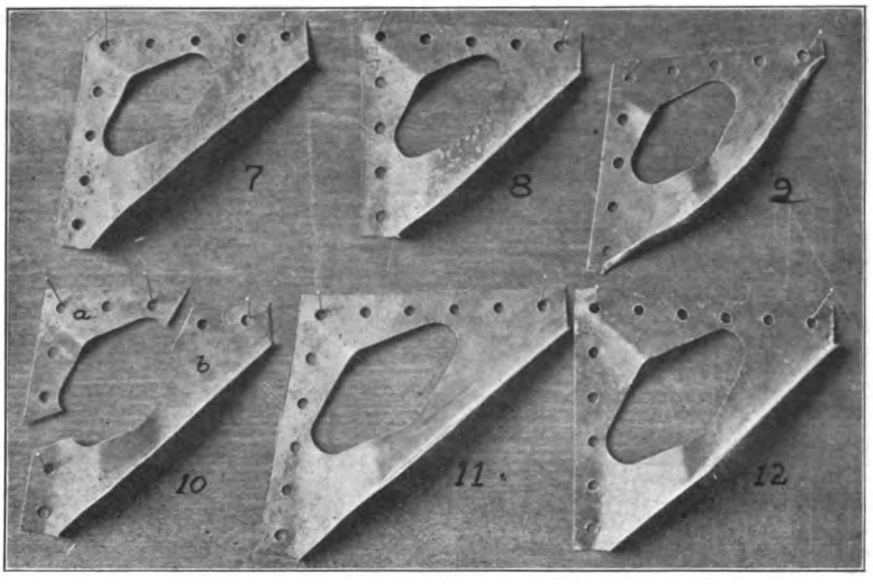

FIG. 7.

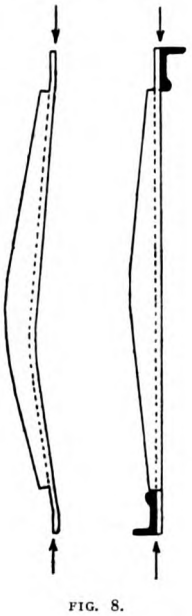

FIG. 8.

As regards the tapered forms of the flange, the experiments showed that its proportions were practically correct. Failure always occurred in the tapered portion of the flange, never nearer to its end than in the case of the specimens shown in the photographs; and as the failure was sometimes near the middle, sometimes near the end, and at about every point between, a fact also well shown by the photographs, it is a fair inference that the amount of taper given to the flange is about correct. Although the writer has considered the possibility of determining the proportions of the flange by rational means, no method for doing so has presented itself which would seem to be justified by the results of the experiments.

We pass now to a consideration of the strength of the taper-flanged, lozenge-lightened bracket from the theoretical standpoint, and the determination of a practical working formula, based on these experiments for use in proportioning a bracket to suit any given case.

It appears that the interpretation of the results of the tests and the determination of a rational method of design should be based upon the following principles:

(a) The load in the rivets varies directly as the distance from a point which corresponds to the neutral axis of a beam.

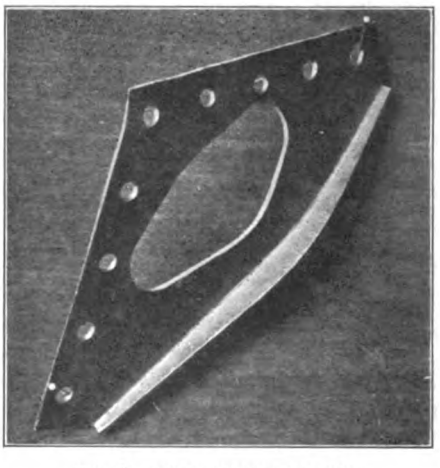

FIG. 9.—TAPER FLANGED BRACKET.

(b) In determining the load in the bracket rivets, the rivets connecting the stringer plate to the stringer angle for the extent of one frame space should be considered as forming part of the connection.

(c) The load from the two (or three) outermost rivets is transmitted through the flanged portion of the bracket, that

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is the portion outside the lightening hole, and this portion of the bracket acts as a column or strut.

(d) The load from the remainder of the rivets is transmitted through the throat portion of the bracket, and this load being small, as compared with that through the outer portion, the strength of the outer portion determines the strength of the bracket.

As it is usual to base the column formulas upon the value of $\frac{l}{r}$, that is the column length divided by the radius of gyration of the section, a second series of tests was made with specimens as shown in Fig. 7, brackets Nos. 7, 8, 11 and 12. Type No. 7 has already been described. No. 8 is similar to No. 7, but the throat angle is 90 degrees. No. 11 is made of the same gage steel as No. 7, and has the same throat angle, depth of flange, etc., but is sufficiently large to take one additional bolt in each connection. No. 12 is similar to No. 11, but the throat angle is 90 degrees. For this second series, three specimens were tested of each type, except No. 7, of which there were four. All of these brackets had the same

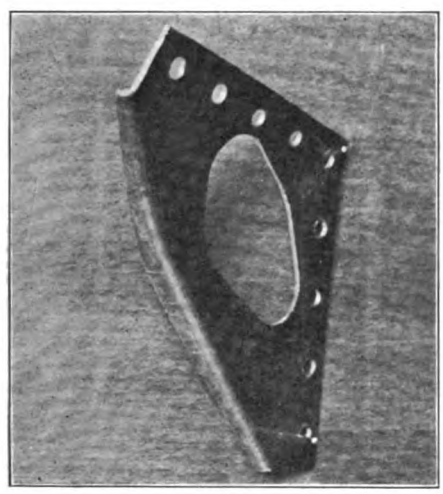

FIG. 10.

value of r for the strut portion, since the depth of the flange was the same in all cases and the lightening hole was the same distance from the edge, but there were four values of l. While a greater range of values of $\frac{l}{r}$ would have been desirable, this was about the best that could be done with the facilities available. The bolt for controlling the position of the neutral axis was, as previously explained, shifted to G. Fig. 5.

Calculations were now made to determine what would be, for any moment M, the load transmitted to the outer or strut portion of the bracket. The details of these calculations are similar to those which are to be described later for the case of a full size bracket and need not be given here. They resulted as follows, the load being in pounds when the moment is in inch-pounds:

Bracket No. 7, load $= 0.188M$
" " 8, load $= 0.188M$
" " 11, load $= 0.150M$
" " 12, load $= 0.150M$

These are the loads in the two outer bolts in each case. For bracket No. 7 the total load in the remaining three bolts was calculated, and as a rough check on the theory of the distribution of the loads in the rivets, three specimens were cut as indicated by No. 10, *a* and *b*, Fig. 7, and the throat and strut portions were broken separately with the following results: Calculated ratio

$$\frac{\text{strut}}{\text{throat}} = 2.71$$

Average of three tests

$$\frac{\text{strut}}{\text{throat}} = 2.24$$

Although the conditions in the intact bracket were not, of course, really reproduced in the "*a*" and "*b*" portions when tested separately, the results indicate that the theory of the distribution of the load in the rivets is not widely at variance with the facts.

Before giving the tabulated results of the tests on brackets 7, 8, 11 and 12, one more explanation is necessary. As will be seen in Fig. 8, the load on the strut portion of the bracket is not central, but eccentric, giving rise to a bending moment, the stress due to which must be allowed for and included in the real ultimate breaking stress. As the amount of the eccentricity and the dimensions of the cross-section are the same for all four types, the unit stress in the extreme fiber, due to the eccentricity of the load, bears for all four types the same proportion to the applied load and is shown by calculation to be 20.5 times the total direct load when the latter is taken in pounds, and the stress due to the bending moment is expressed in pounds per square inch.

The following table shows the actual results of this series of tests and the calculated results derived from them. The values of l are taken as the respective lengths of the flange, which, being about the same as the length between the outermost rivets, is, probably to all intents and purposes, the true column length, and is, at all events, the most convenient for practical use.

(To be Concluded.)

TABLE OF RESULTS.—SERIES 2.

Type No.	l Inches.	r Inch.	$\frac{l}{r}$	Area of Section Square Inch.	Actual Ultimate Moments in Pounds.	Average Ultimate Moments in Pounds.	Percent Variation.	Average Load, Pounds.	Unit Load Pounds per Square Inch.	Unit Stress Due to Eccentricity (Compression).	Total Unit Load, Pounds per Square Inch.
7	5.	0.116	43	0.0272	1,713 1,455 1,740 1,470	1,577	11.3	297	10,900	6,100	17,000
8	4.3	0.116	37	0.0272	2,125 1,910 1,885	1,973	7.7	371	13,650	7,400	21,050
11	6.25	0.116	54	0.0272	1,440 1,785 1,485	1,570	13.7	235	8,650	4,840	13,490
12	5.5	0.116	47.5	0.0272	1,542 1,355 1,300	1,399	10.2	209	7,700	4,290	11,990

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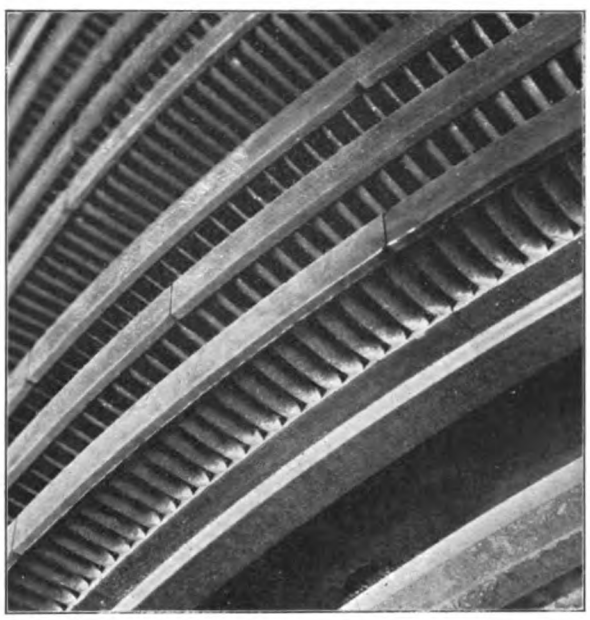
REPAIRS TO THE TURBINES OF THE U. S. SCOUT CRUISER SALEM.

The United States scout cruiser *Salem* has been sent to the builders, the Fore River Shipbuilding Company, for an examination of the main propelling turbines, which are of the Curtis marine type. During the recent competitive trials the starboard turbine ran considerably slower than the port, with the same steam supply, thus indicating that some internal



BUCKETS IN FRONT ROW BENT OVER, COMPLETELY CLOSING STEAM PASSAGE.

derangement had occurred, although there was no difficulty in its operation.

When opened up it was discovered that some foreign body had become caught in the fifth stage between the nozzles and first row of buckets. It had bent over the edges of the buckets so as to completely prevent any steam passing through them, and had broken about one-quarter of the nozzle division plates. The foreign body which caused this has not yet been found, but a loose 5/8-inch nut was found in the fifth stage, lying in the bottom of the casing, which did not become caught in the moving parts.

Examination of the port turbine disclosed a service bolt, 2½ inches long, which was not a part of the machine, lying in the first stage against the nozzle openings leading to the second stage. The damage done here was comparatively slight.

The rotors of both machines were also found to have moved axially, so as to allow the moving buckets to rub against the stationary guide blades, with the result that in the first and second stages, where the axial clearances are least, the guide blades were worn on the edges, but no blade stripping occurred. As in these stages the guide blades only cover a small part of the circumference, practically all the wear occurred on them and very little on the moving buckets. All blading was found to be entirely free from any erosion due to the action of the steam, and the surfaces were as smooth as when first installed.

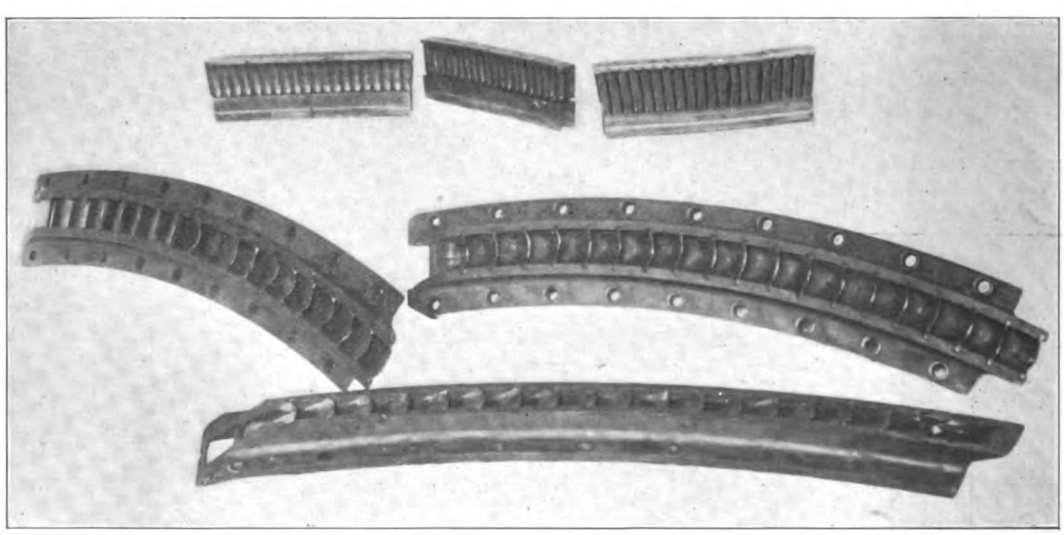
This shows that the Curtis type of construction has a remarkable ability to withstand abuse and still remain in operative condition; as even in this condition the vessel made 24½ knots for twenty-four hours, and for the first eight hours made 25 knots, while the contract speed required 24 knots for four hours. Also the operation of the turbine was perfect, and except for the drop in revolutions it would not have been known that any internal damage had occurred.

The damage is being repaired, and is expected to be finished in thirty days from the vessel's arrival at the builder's yard.

THE LAPLAND.

The Red Star Line has recently placed on its New York-Dover-Antwerp service the new twin-screw steamship *Lapland*, of 18,694 gross tons, built by Messrs. Harland & Wolff, of Belfast, Ireland. The vessel is 620 feet long over all with a breadth of 70 feet and a depth from the keel to the top of the shelter-deck beams of 50 feet. With a displacement of 30,500 tons, the load draft is 35 feet 3 inches. Quadruple expansion engines are installed, with a total indicated horsepower of 13,000. Accommodations are provided for 394 first class, 352 second class and 1,790 third class passengers.

The *Lapland* was built in accordance with the requirements of the British Board of Trade and the American and Belgian laws for passenger vessels. The hull is divided into eleven watertight compartments; a centerline bulkhead being provided for additional safety. The double bottom extends throughout the entire length of the ship, and is made excep-



DAMAGED BLADING OF THE SALEM'S TURBINE.

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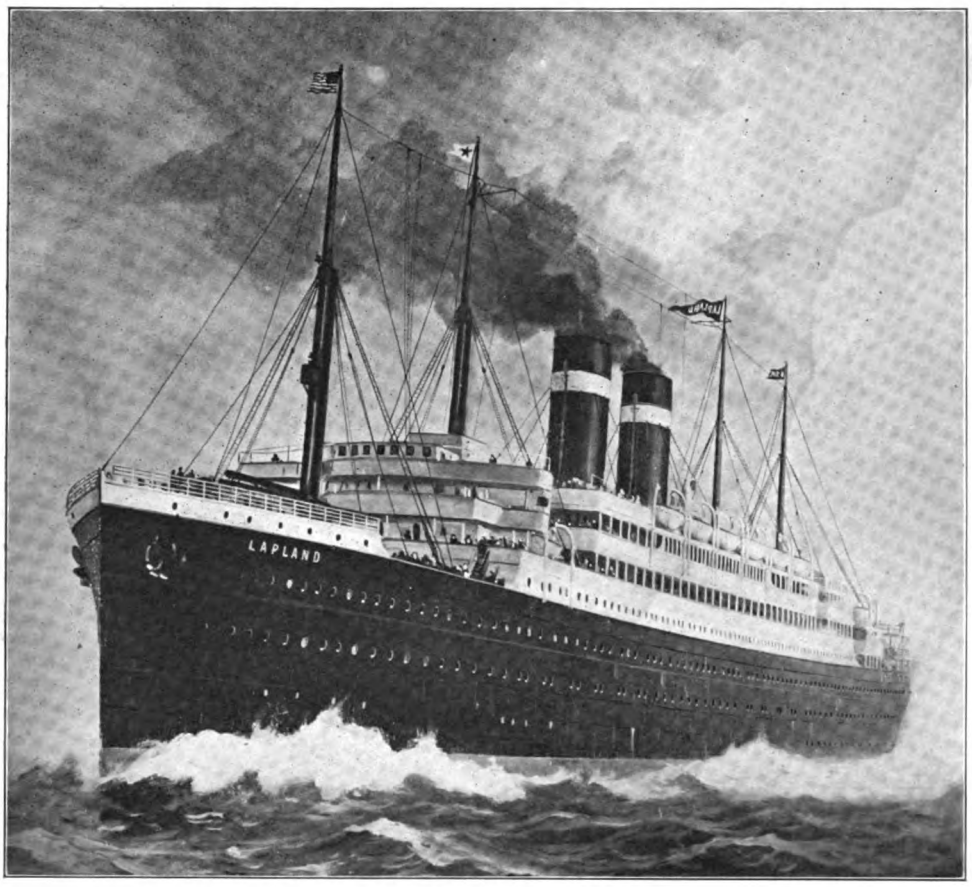

THE NEW RED STAR LINER LAPLAND.

tionally rigid in the machinery space. There are nine decks and six cargo holds. The coal bunkers are arranged so that the ship can be coaled from either side.

All the first class accommodations are situated in the superstructure amidships. On the upper promenade deck are situated the lounge, the reading and writing room, and the smoking room. The lounge is decorated in the style of the early Georgian period, with walls and ceiling paneled in oak. At the after end is an ingle nook with a handsome fireplace. Mahogany furniture and large windows upon which are appropriately painted scenes in various Belgian and American cities add much to the attractiveness of the room. Card tables and writing desks are also provided. The reading and writing room is situated amidships and is decorated in white. As in the lounge, there is an ingle nook with an attractively designed fireplace. In the smoking room special attention has been paid, not only to decoration and comfortable furnishing, but also to the ventilation. The walls are of paneled oak, and upon them are displayed views of various Belgian, American and English cities. The ceiling is also set in panels, but there is a large colored-glass dome in the center bearing in medallions the twelve signs of the Zodiac. Located aft, and adjacent to the smoking room, is a veranda café, finished in enameled white and furnished with teakwood chairs and small tables, arranged after the style of out-door cafés on the Continent.

Other special features located on the upper promenade deck are a photographic dark room and a small shop, where a great variety of articles necessary for the comfort of the passengers can be purchased. An electric elevator is installed to convey passengers from the upper promenade deck immediately to the entrance of the dining saloon or to the various stateroom decks.

CORNER OF THE LAPLAND'S DRAWING ROOM.

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The first class dining saloon extends the entire width of the vessel, a distance of 70 feet, and at the sides large windows are arranged in pairs to insure good light and adequate ventilation. The room is paneled in white and old gold, the furniture being of oak. Small tables, arranged in the popular restaurant style, are provided. At the forward end there are two sideboards of carved oak, with a piano of the same wood between them, while overhead a small balcony provides a convenient place for the ship's orchestra. In the center of the saloon is a large dome, with a surrounding balustrade.

The staterooms are arranged in a variety of ways, from suites de luxe, consisting of sitting room, bedroom, bath and toilet, to single-berth rooms. Where cabins are designed for two or more passengers, all the upper berths are built in the Pullman folding style. A large amount of deck space is available for the passengers, particularly on the sun, upper promenade and promenade decks. The upper promenade deck is fitted with wind screens containing windows, so that the deck may be entirely inclosed in bad weather.

THE LOUNGE ON THE LAPLAND.

The second class accommodations have been given careful attention, the dining saloon, which extends the full width of the vessel, having a seating capacity of 220 persons. It is finished in white and gold, with mahogany furniture, with a handsome sideboard and piano at one end. The second class library is a large room, paneled in sycamore, with mahogany furniture. In the smoking room the walls and furniture are of oak, while a large skylight with embossed glass and large windows at the sides of the room provide ample light and ventilation.

The third class accommodations include two, four and six-berth rooms, together with a large social hall on the shelter deck.

Change of Address.

On May 1, 1909, the address of the North-East Coast Institution of Engineers & Shipbuilders was changed to Bolbec Hall, Westgate Road, Newcastle-upon-Tyne.

MAST AND DERRICK MOUNTINGS.

COALING AND SAMSON POST DERRICKS.

Fig. 1 shows a Samson post and coaling derrick 25 feet long, 9 inches diameter at the center and 6 inches at the ends. The forks of the shod are 31 inches long from the center of the pin. At the heel end the forks are 3¾ inches broad by ⅝ inch thick, tapering to 2½ inches by 9/16 inch at the inner end. Three ¾-inch clinched bolts are driven through the derrick and clinched on the forks; two bands are also fitted, the aftermost one is 3¼ inches broad by 9/16 inch thick, the inner one 2¾ inches broad by 9/16 inch thick. The aftermost band is 9½ inches from the center of the pin, the inner band is 27 inches from the center of the pin. The snug through which the pin passes is 4 inches deep by 1⅞ inches thick. The pin is turned steel 1¾ inches diameter.

The gooseneck sole is 16 inches long by 11 inches broad and ⅞ inch thick, arranged to take six ⅞ inch rivets. From the sole extend two jaws; the upper is 3¼ inches deep by 5 inches broad, and the lower 2¼ inches deep by 5 inches broad. The 3½-inch space in between the jaws is used for fitting the link to take the leading block to the winches, etc. The link at the attachment to the leading block is 1¼ inches diameter and must be long enough to allow the shackle of the leading block to ship and unship easily. Through the body of the link a hole 2⅜ inches diameter is bored to allow the spindle to pass through easily, and thus allow the link to move to follow the lead block as it moves to its work. The jaws for the heel fitting are 1¼ inches thick, with a 2-inch space between. The spindle as it passes through the upper jaw of the gooseneck plate is 3 inches diameter (for thickness of upper jaw only), for the remainder of its length it is 2¼ inches diameter. At the underside of the lower jaw a split forelock pin is fitted to prevent lifting when loads are applied. The center of derrick pin is 4 inches above the upper jaw of the gooseneck plate, and is 7 inches from the sole. The type of gooseneck

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plate shown here is for fitting against a casing or bulkhead, but can be curved to suit a mast or Samson post.

The head-fitting band is 4 inches broad by ¾ inch thick, with a snug on the upper side 1⅜ inches thick, suitable for taking a 1¼-inch shackle. To the shackle is fitted a 1-inch link to take a ⅞-inch chain as a topping lift. If the ⅞-inch chain does not find favor with ship owners, a 3-inch S. W. rope may be substituted, the working load of each being about 8¼ tons. A ¾-inch eye is fitted on each side of the band to take guys. A 1¼-inch eye is fitted on the bottom of the band to take a 1¼-inch link; to this link is fitted the shackle of the gyn block. At the head of the derrick a plate is fitted at top and bottom and end, with two snugs to prevent the band moving when a load is applied.

Attention should always be paid to see that snugs are fitted at bands with screws or clinched bolts; when care is taken about the fitting of those small details it saves much time and trouble afterwards. The band is usually fitted 1 foot from the head of the derrick.

The hoop for the coaling derrick is 3½ inches broad by ⅝ inch thick, and has two snugs set at angles on the upper side to take topping lift guys. With the style shown here, the derrick heel is supposed to be fitted slightly above the deck, with topping lifts fitted to the casings. On the lower edge of the band is fitted a 1⅛-inch wrought eye, with a suitable link to take the gyn block.

5-TON DERRICKS.

Fig. 2 shows a 5-ton derrick 46 feet long, 13 inches diameter at the center and 11 inches at the ends. The derrick shows bands for taking two gyn blocks. The upper band is 9 inches from the head of the derrick, and the distance between the bands may be anything from 4 feet 6 inches to 6 feet.

The forks of the shod are 3 feet 2 inches in length from the center of the pin. The forks at the end of the derrick are 4 inches broad by ⅝ inch thick; at the inner end the breadth

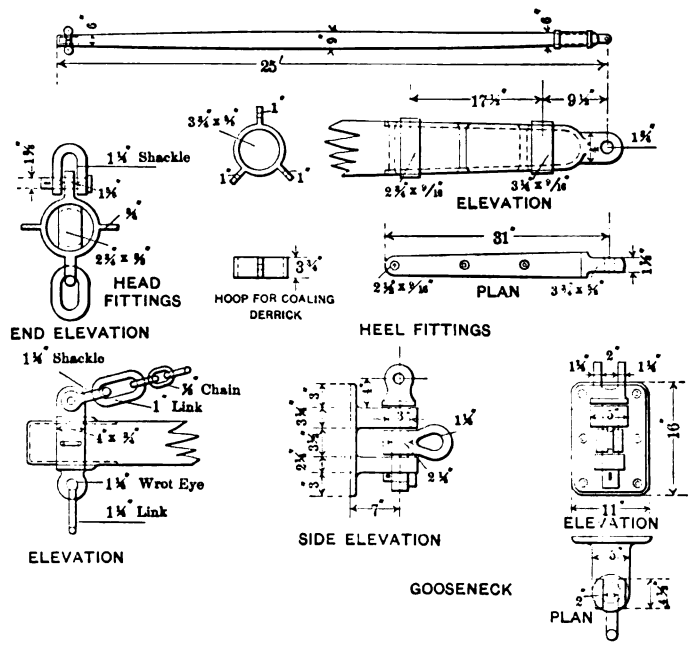

FIG. 1.

The jaws of the goosenecks are 1¼ inches thick, with a distance of 2⅛ inches between, suitable for the thickness of the shod snug. The flat of the jaws is 4½ inches broad to take a pin 1¾ inches diameter. The neck of the gooseneck is 6 inches diameter, a dimension which gives plenty of area for resting on the socket. The spindle is 3 inches diameter

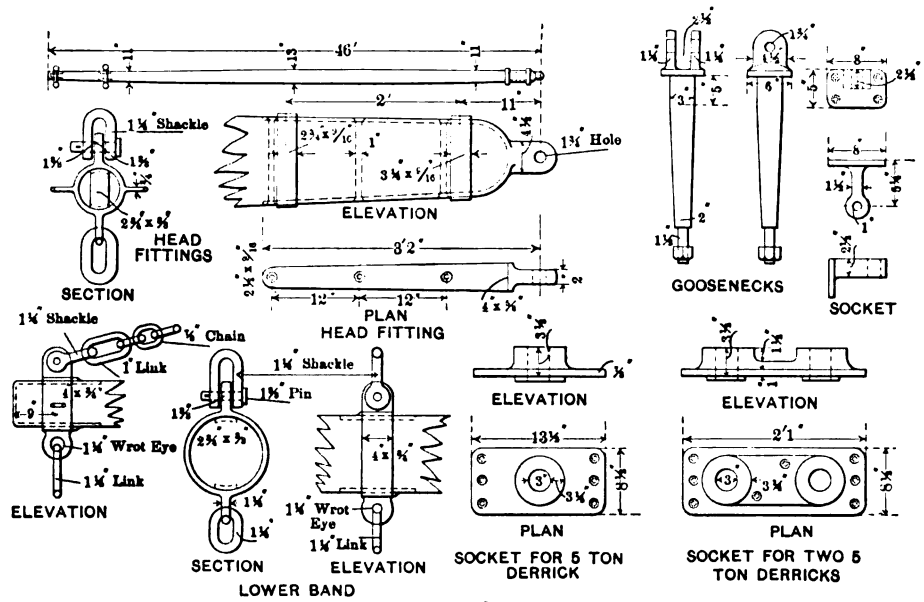

FIG. 2.

is 2 inches, and the thickness 9/16 inch. Through the shod three 1-inch bolts are driven and clinched, and spaced 12 inches apart. A band 3¼ by 9/16 inch is fitted 11 inches from the heel, and a second band 2¾ inches by 9/16 inch is fitted 2 feet 11 inches from the heel. The snug at the end of the shod through which the pin passes is 4½ inches deep by 2 inches thick. The pin is of steel 1¾ inches diameter.

The derrick sockets are castings, with a sole 13½ inches long by 8½ inches broad, with a base ⅞ inch thick; from base to crown it is 3½ inches deep. The diameter of the spindle is 3 inches, and the overall diameter of the crown is 9¼ inches. The socket is fitted to the mast table with six 1-inch rivets or bolts. The thickness of the spigot is made to suit the thickness of plating on the derrick table.

for a length of 5 inches, when it begins to taper to 2 inches till it reaches the upper edge of the socket on the center plate of the mast platform, when it becomes 1½ inches diameter, retaining this diameter to the end. The portion on the underside of the socket on the center plate of the mast platform is screwed and a nut fitted. Through the nut and spindle a hole is bored and a tapered pin fitted to prevent the nut being lost. The length of the gooseneck is entirely dependent upon the depth of the center plate of the mast platform.

The sole of the socket is 8 inches broad by 5 inches deep by

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¾ inch thick, and it is arranged to take four rivets. The arm of the socket is 2½ inches deep by 1½ inches broad, and 1 inch of metal is left all round the boss. From the edge of the plate to the center of the boss, the distance is given as 6¼ inches; this dimension is only a relative one, as the centers of derricks before and abaft the web plate of the mast platform determine this.

The upper and lower bands are 4 inches broad by ¾ inch thick, with 1⅜-inch snugs on top for taking a 1¼-inch shackle, with a 1-inch link and ⅞-inch chain. A 1¼-inch wrought eye is worked on the lower edge, with 1¼-inch links to take gyn blocks. Three-quarter-inch eyes for guys are fitted on the sides of the upper band only. To each band the usual snug plates are fitted, to prevent the bands shifting when the loads are applied. The snug plates are 2¾ inches by ⅜ inch.

A sketch is shown here of two derricks fitted in one socket. The socket is a casting 2 feet 1 inch long, 8½ inches broad, long, 9 inches broad and 1 inch thick. The crown is 3½ inches above the base and is 8 inches broad. Through the crown a hole is bored to suit the spindle of the gooseneck; this leaves 2 inches of metal all round the crown. A spigot is arranged for on the underside of the sole to suit the thickness of the mast table plating. The socket is secured to the mast table plating by six 1⅛-inch rivets.

The jaws of the goosenecks are 1⅛ inches thick by 5 inches broad, with the center of the 2½-inch diameter pin 5 inches above the throat of the jaws; this leaves the center of the derrick pin 8½ inches above the mast table. The spindle is 4 inches diameter for a distance of 5 inches below the throat; then it tapers to 2½ inches; the length of this taper is determined by the depth of the mast table center plate. When the spindle reaches the socket on the web of the mast platform it is 2 inches parallel, and a portion below the socket is screwed, and a nut is fitted with a hole bored through the nut and

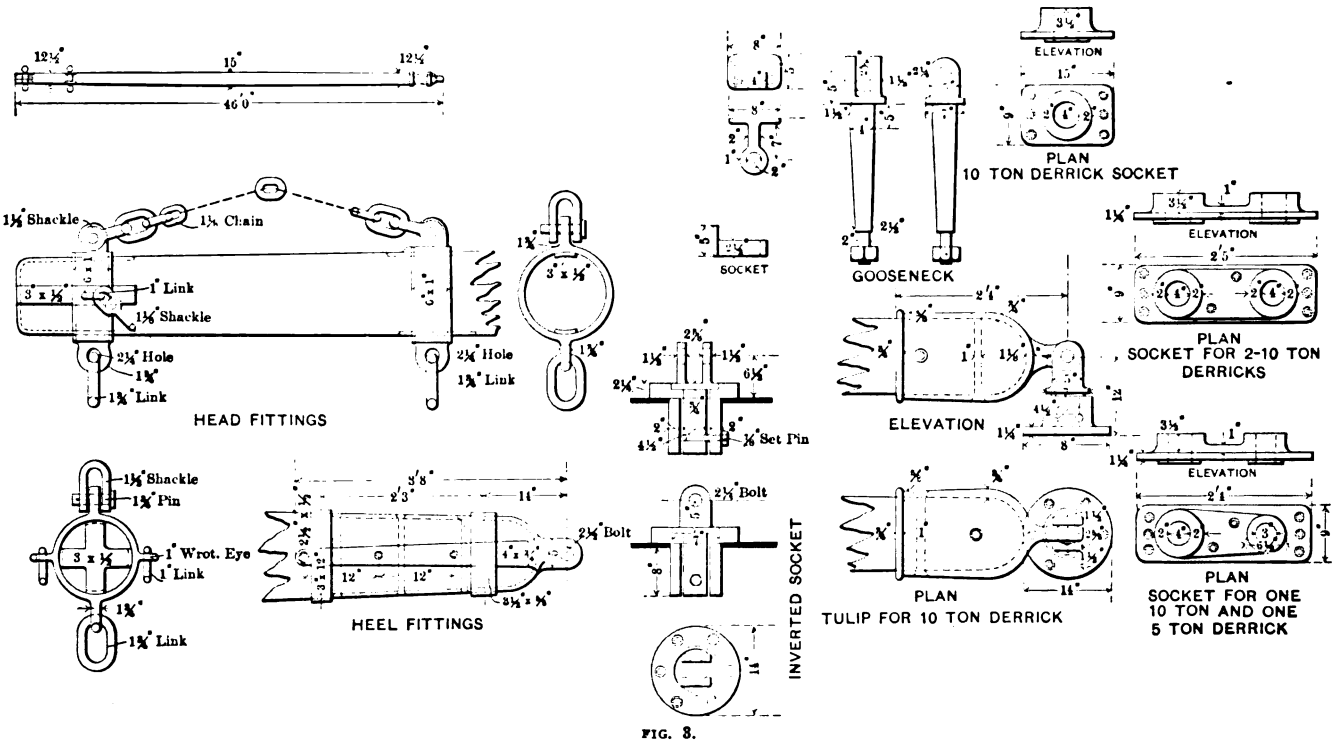

FIG. 8.

with a sole 1 inch thick. The top of the crown is 3½ inches above the base plate; the diameter of the crown is 9¼ inches overall; between crowns is a raised portion 1 inch deep. The socket is fixed in place with eight 1⅛-inch rivets or bolts. The distance between the two centers of the derricks must be regulated by the distance of the derrick heels on each side of the web plate of the mast platform.

The heel fittings are drawn for a derrick fitted on a mast platform.

10-TON CARGO DERRICKS.

Fig. 3 shows a 10-ton cargo derrick 46 feet long, 15 inches diameter at the center, 12½ inches diameter at the ends, with double bands arranged to take purchase or gyns.

The heel fitting is of the four-forked shod type. The length of the forks is 3 feet 8 inches from the center of the pin; the forks are 4 inches broad by ¾ inch thick at the heel and 2½ inches broad by ½ inch thick at the inner end. They are connected together through the derrick by six 1-inch clinched bolts, spaced 12 inches apart. A band 3½ inches by ⅝ inch is fitted 14 inches from the pin; a lighter band 3 inches by ½ inch is fitted at a distance of 3 feet 5 inches from the center of the pin. The bolt snug is 5 inches deep by 2½ inches broad, and takes a 2½-inch bolt.

The single-derrick socket is a casting with a sole 15 inches

spindle to prevent the spindle from lifting when loads are applied.

The sole of the gooseneck socket is 8 inches long by 5 inches broad by ¾ inch thick, and is bored to take four rivets. The socket arm is 2½ inches deep by 2 inches broad; 1 inch of metal is left clear all round the boss. A distance of 7 inches is given from the sole to the center of the boss, but this is only relative, as this distance must be made to suit the distance of the derrick heel from the center plate of the mast table.

The tulip and socket shows an alternative heel fitting for derricks. The tulip is a casting 2 feet 4 inches long from the center of the pin, and is of the following thicknesses: At the derrick heel 1⅛ inches; 12 inches from the center of the pin, ¾ inch; at the end of the tulip, ⅝ inch. A ¾-inch rib is arranged for at the end. Two 1-inch countersunk bolts are driven through the derrick and tulip. The pin snug is 5 inches at the deepest part, 4 inches at the shallowest, and 2½ inches broad. A 2½-inch bolt passes through the snug.

The gooseneck jaws are 1½ inches thick by 5 inches broad, with a distance of 2⅝ inches between them. The spindle is 4½ inches diameter, with a 1-inch groove all round. A 1-inch pin is fitted through the socket and spindle to prevent the derrick lifting, and is securely fastened to the socket with

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keep-chains. The fitting of the groove in the spindle allows the derrick to move freely to its work. The socket may be a casting or forging, and is of the following dimensions: Sole, 14 inches diameter, 1 inch thick; crown, 8 inches broad, 1¾ inches metal all around the spindle, 7 inches high from the bottom of the hole; six 1-inch rivets are provided for in sole.

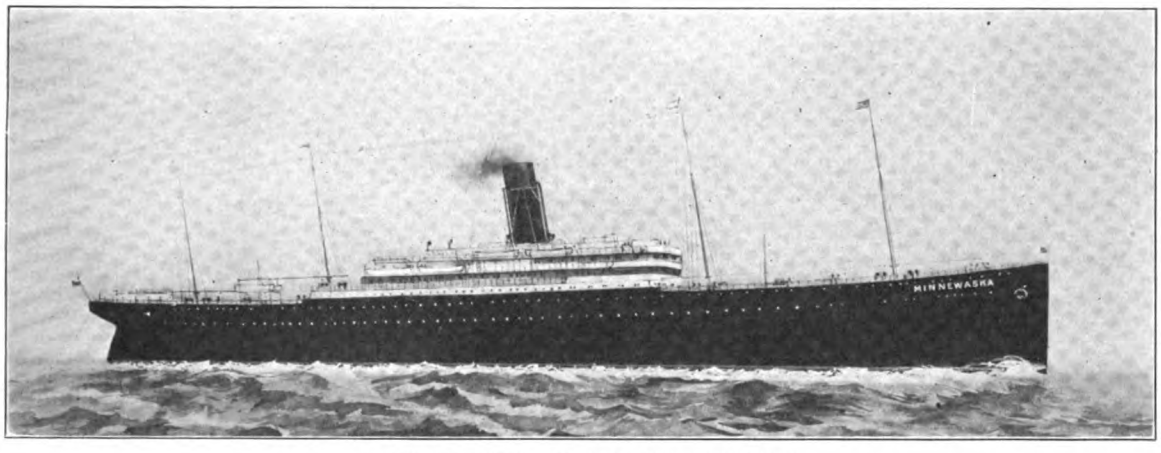
A sketch is also shown of the well-known inverted socket. The sketch, however, is self-explanatory.

THE MINNEWASKA.

The Atlantic Transport Line has recently placed in service a new passenger and freight steamship of 14,500 tons. This ship, which is named the *Minnewaska*, was built by Harland & Wolff, of Belfast, and is a sister ship to the other four 600-foot vessels of the Atlantic Transport Line, two of which were built by Harland & Wolff, and the other two in the United States.

The principal dimensions of the *Minnewaska* are: Length, 615 feet 3 inches; beam, 65 feet 3½ inches; molded depth, 44 feet; load draft, 33 feet 2 inches; displacement, 26,530 tons; horsepower, 11,000; speed, 16 knots.

The hull is divided by bulkheads into eleven watertight compartments. There are five steel decks throughout, and a double bottom extending from the forward collision bulkhead to the stern-tube bulkhead. The tanks have a total capacity of 4,300 tons, and the coal bunkers a capacity of 1,890 tons. The passenger accommodations are placed amidships in the superstructure, leaving the entire deck forward and aft free for handling cargo. There are nine cargo hatches, five forward and four aft. The cargo booms are swung from four pole masts and two derrick poles. There are four booms on each mast and two on each derrick pole. Each boom is served by a separate steam winch.



THE NEW ATLANTIC TRANSPORT LINER MINNEWASKA.

The ship is propelled by two sets of quadruple-expansion engines, each having four cylinders. The sequence of cylinders is from forward aft—high pressure, second intermediate; low pressure, first intermediate. Piston valves are fitted to all cylinders except the low pressure, which has a flat, double-ported slide valve. Each cylinder is a separate casting, and is supported by cast iron box columns, the condenser being cast in the outboard columns. The bed-plates are also cast iron and of box section. The diameters of the cylinders are 30, 43, 63 and 89 inches, with a common stroke of 60 inches. At a speed of 75 revolutions per minute the indicated horsepower is estimated as 11,000.

Steam is furnished at a working pressure of 215 pounds per square inch by four double-ended and four single-ended Scotch boilers, each 14 feet 5 inches in diameter. The double-ended boilers are 19 feet 10 inches long, and each has six corrugated furnaces, 40 11/16 inches inside diameter. The single-ended boilers are 11 feet long, and each has three furnaces, 40 11/16 inches inside diameter. The total grate surface is about 642 square feet, and the total heating surface 26,336 square feet, making a ratio of heating surface to grate surface of 41.02. Howden's system of forced draft is installed.

The propellers are each three-bladed, 18 feet 6 inches in diameter, 23 feet 6 inches pitch. They have cast iron bosses and bronze blades. The propeller shafting is 18¼ inches in diameter, the intermediate shafting 17 inches in diameter, and the crank shafting 18 inches in diameter; all shafting being of mild ingot steel.

The air, bilge and sanitary pumps are driven by levers from the first intermediate cross-head. The feed pumps are of the Weir automatic type, while the general service pumps are duplex pumps of the Admiralty type, made by the builders of the vessel. The circulating pumps are of the centrifugal type, there being one for each main engine and one for the auxiliary condenser, which is used while the vessel is in port, and which receives steam from the winches. These pumps are also made by the shipbuilders. A Weir feed-water heater is installed, and there is also an evaporator and distiller. The electric equipment is very complete, there being four generators of about 35 kilowatts capacity each. Electricity is used for driving the ventilating fans, of which there are a great number throughout the ship, as well as for lighting, heating and various small pieces of apparatus designed for use in the staterooms. The steering gear consists of a Brown's steam tiller and telemotor.

The passenger accommodations are all for first class passengers, of which 326 may be carried. On the boat, or upper, deck, forward, is the lounge, which is finished in white and gold, and is furnished with wicker furniture. There is a handsomely decorated skylight in the center of the room, and at the forward end a large bookcase. Square windows, arranged in pairs, extend around on three sides of the room. Amidships on this deck is the reading and writing room, which is also finished in white and gold panel work with colored windows. The furniture in this room is of mahogany. At the after end of this deck is the smoking room, which is paneled in oak and upholstered in plain crimson morocco. Between the reading room and the smoking room is the Marconi station. The shelter deck is given over entirely to staterooms, of which there is a great variety, ranging from single-berth rooms to suites de luxe, comprising sitting room, bed room and bath. All staterooms are handsomely decorated, and the inside rooms are lighted and ventilated on the Bibby system. At the forward end of the saloon deck is the dining room, which extends the entire width of the vessel, and is framed and paneled in oak.

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FURNACE REPAIRS AT SEA.

The flattening or collapsing of furnaces in marine boilers is, even at the present date, a subject which is invested with a degree of uncertainty. There are several reasons advanced in order to account for the collapsing of such furnaces, but the true causes are not yet made sufficiently clear to entirely prevent the occurrence of such troubles, even with the ordinary amount of careful supervision. A rather interesting example of this class of difficulty recently occurred in the case of a furnace whose diameter was 3 feet 8 inches, and length 6 feet, the steel was 7/8 inch thick, and the boiler pressure was normally 160 pounds per square inch.

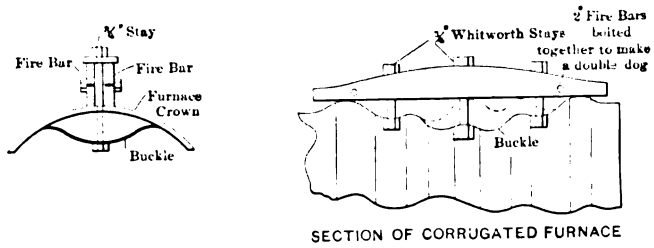
The boiler had been under steam for some time previous to the accident, and the furnace in question partially collapsed about ten days from the beginning of the voyage. Before the voyage, however, the boilers had been under steam for some ten or twelve days at the loading port. Owing to exceptional conditions, the vessel had to have steam raised and the fires banked successively several times in succession. This was because the loading of the cargo had to be carried out under difficulties; the jetty at which the vessel lay was in an open bay, and not in a sheltered harbor, and the vessel had therefore to put off to sea whenever the weather became too bad for her to remain alongside the jetty from which the cargo was being taken. It is probable that this successive raising of steam and banking, in the course of loading, had some effect in causing the furnace to show weakness and to collapse at a later date.

Among other points, it may be fairly allowed that the continued heating and partial cooling of the boilers before actually starting on the voyage caused the scale to crack away from the tubes, so that it dropped on to the furnace crown, becoming lodged in the corrugations and thus preventing free contact of water with the exterior surface of the furnace. The fact that the boilers were under banked fires so much of the time would also undoubtedly conduce to the evil, as boilers have a considerably less active circulation in such cases. This would cause steam to cling to the heating surface, in this way holding the water away from the metal and rendering the furnace liable to overheating.

Another cause which might have been conducive to, although it would not be called the prime origin of, the evil, was the fact that while the boilers were used in moving the ship during loading operations, a considerable amount of water was lost at each operation. This water had, of course, to be replaced, and the only available source from which such supplies could be taken at the time was the sea. No marine engineer cares to put salt water into his boilers, but sometimes there is no alternative. In the case mentioned, the loss was minimized as much as possible and the density did not at any time during the voyage become excessive. At the time that the furnace buckled, and for some days previously, the density had remained the same, as no salt water had entered the boiler after leaving the port. The density was from $\frac{2\frac{1}{2}}{32}$ to $\frac{2\frac{3}{4}}{32}$, or about 12 to 13 ounces to the gallon. This cannot be considered excessive, as the saturation point is reached at $\frac{7}{32}$, or 35 ounces to the gallon.

Blowing down was not resorted to, because, although the density could be lowered in that way, certain solids would be deposited on the heating surface which could not be expelled from the boiler. In this way the trouble would have been aggravated. The course actually pursued was as follows: When the furnace, which was the center and lower furnace in the starboard boiler, buckled, that boiler was shut off, fires were drawn and the water blown out. The connections were all closed and the doors knocked in. As soon as possible the boiler was emptied and examined, and it was decided to stay the furnace according to the method about to be described. The furnaces were also scaled, and a quantity was found in the corrugations although there was practically none on the ridges. This gives rise to the belief that the scale had fallen from the tubes, having been cracked off by the expansion and contraction, due to the raising and banking of fires at the beginning of the voyage.

The furnace was stayed, as shown in the illustration, by means of three 3/4-inch studs passing through the middle of



SECTION OF CORRUGATED FURNACE

TEMPORARY REPAIRS TO A COLLAPSED FURNACE.

the furnace, to which was clamped a double dog, made of two ordinary firebars bolted together and laid lengthwise on the furnace crown. During the time the boiler was laid off, the engines were kept going by the remaining boiler. Although the furnaces were scaled and a temporary dog fixed in place on the low furnace, the boiler furnace was cleaned, the doors replaced, the boiler filled up, the fire lighted and steam raised in about 36 or 38 hours. As this time includes that necessary for the boiler to cool, and also to raise steam at the end of the repair, it may be considered a fairly quick piece of work.

On arrival at the discharging port, the boilers were both laid off and the furnaces put back into circular shape again by means of a hydraulic ram. The Whitworth stays, shown in the sketch, were renewed by threaded stays 1 inch in diameter, and instead of the three shown, five were used. This port repair was therefore practically a repetition of the one made at sea, only accomplished with better materials and more facilities.

A GAS-DRIVEN LAUNCH.

The accompanying illustrations show the adaptation of a producer gas plant to a 40-foot cabin cruiser built by MacLaren Bros., of Dumbarton. The boat, which has been named the *Pioneer*, has been built and equipped throughout by the same firm, the engine alone being made outside the Sandpoint yard. The gas plant is of the suction type, employing anthracite coal as fuel. A hopper of sufficient capacity for four hours' running is situated immediately over the producer, and can be replenished through a hatch in the fore-end deck. The producer plant appears to be similar in design and construction to those already in use for land purposes. The necessary water supply for cooling and scrubbing the gases is obtained from the sea, the salt water having proved to be, we are informed, quite satisfactory for this work. A certain amount of fresh water must, however, be carried for supplying the vaporizer, and as only a comparatively small quantity is used for this purpose, a sufficient supply is provided in the bilge tanks of the vessel for thirty-six hours' continuous running. Fuel accommodation is also provided for this period.

No provision is made with regard to shaking the fire grate to prevent clinkering, for, according to the makers, the motion

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of the vessel is quite sufficient. Coke is employed as a cleansing medium in both the wet and dry scrubbers. In the former the gas enters at the bottom, meeting a spray of sea water from the top. Reaching the upper portion of the wet scrubber

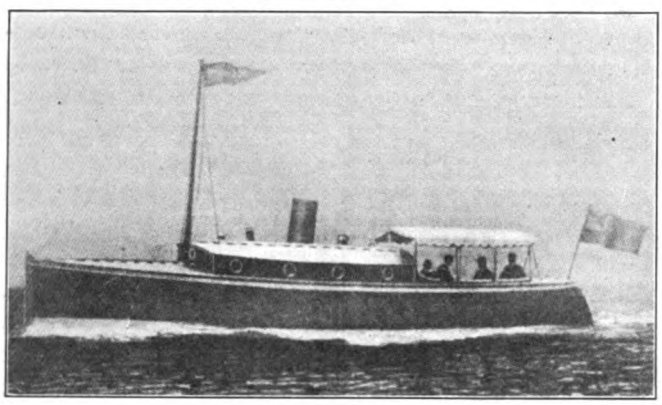

FIG. 1.—40-FOOT CABIN CRUISER PIONEER.

the gas is taken to the dry scrubber, through which it passes in a downward direction.

The water spray is found to give ample cooling of the gases, and, provided fairly clean coal is used, cleaning of the scrubbers is only necessary at very long intervals.

The engine fitted (Fig. 2) is a four-cylinder Crossley of 30 nominal horsepower, but it gives rather more than this when running on producer gas. The engine speed is low for the type of engine, the maximum being 800 revolutions per minute. The compression is very high, being approximately 120 pounds per square inch, and it is claimed that combustion is quite complete. When the engine is cold it is started up on petrol (gasoline) and runs on this fuel until the necessary quality of the gas can be obtained from the producer.

The engine is set in a true horizontal plane, and it drives

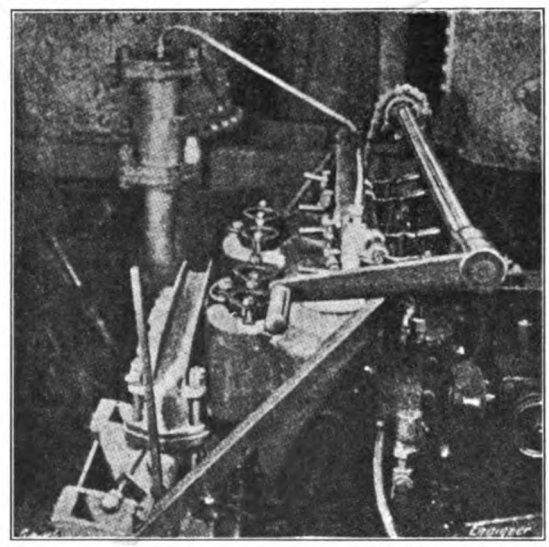

FIG. 3.—FOUR-CYLINDER, 30 HORSEPOWER CROSSLEY ENGINE.

through a universal joint an inclined propeller shaft, which carries a two-bladed reversible propeller.

A trial run was made recently at which a number of Clyde yachtsmen and gas engineers were present. Although the weather conditions were most unfavorable, satisfactory runs with and against the wind were made, a mean speed of 9 knots being attained. The cost of running was calculated at 2½d. per hour. We are informed that the engine showed a remarkable flexibility on suction gas, and a total absence of smoke or smell either in the engine room or at the funnel was another feature of the plant. We understand that MacLaren Bros. are at present negotiating for some large ships which are to be fitted with a suction gas producer plant.—*The Engineer.*

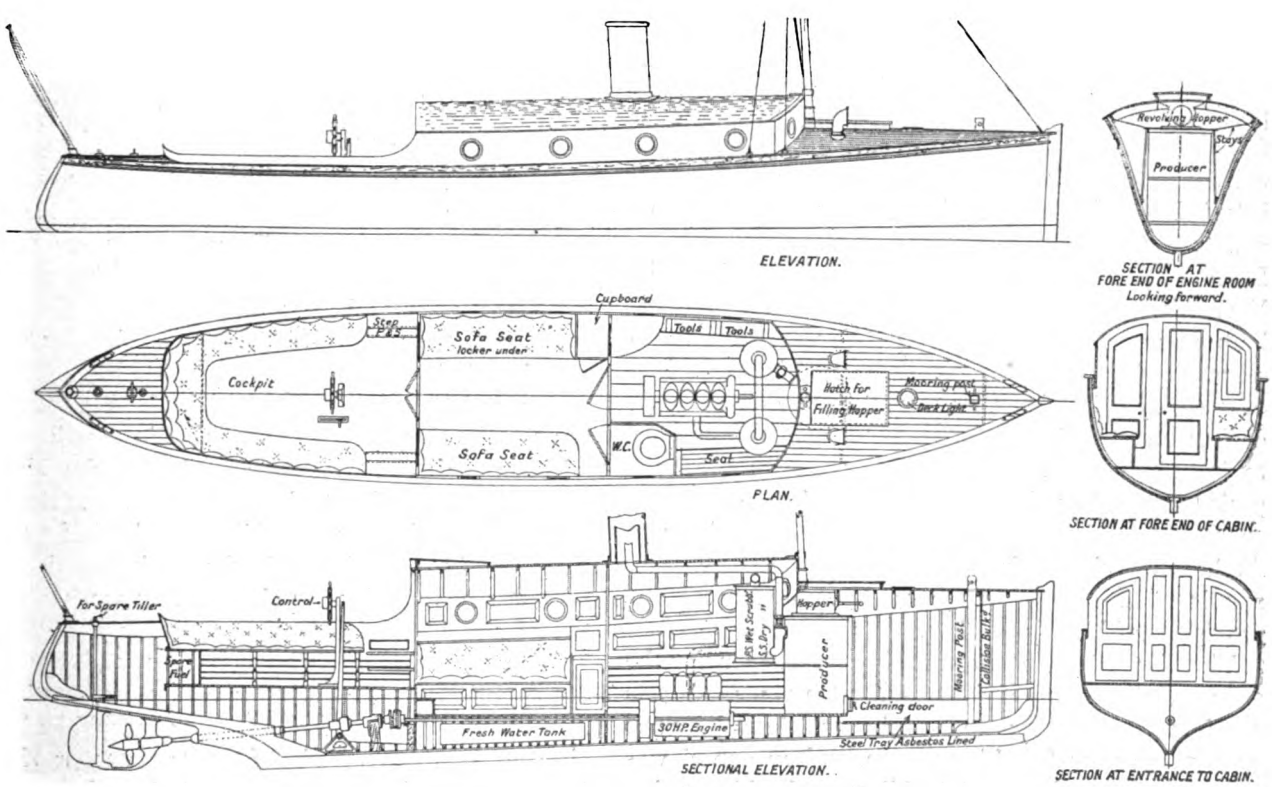

FIG. 2.—GENERAL ARRANGEMENT OF THE CABIN CRUISER PIONEER.

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A Towing Tank for Research Work.

Somewhat over a year ago Mr. A. F. Yarrow, vice-president of the Institution of Naval Architects, offered to build an experimental model towing tank, provided one of the most modern character could be established for a sum not exceeding £20,000 ($97,330), and that it be established at the National Physical Laboratory, at Bushy. It was also stipulated in Mr. Yarrow's offer that suitable provision should be made both as regards staff and means for conducting research work, as well as for experimental investigations of a confidential character which private firms might desire; and, finally, that a sufficient sum be provided to insure the tank being efficiently carried on for a period of not less than ten years. This proposal was submitted to the council of the Institution of Naval Architects and gratefully accepted, a committee being appointed to take the necessary steps to carry out the provisions of Mr. Yarrow's proposal.

The first thing done was to make provision for the proper maintenance of the tank for ten years. It was considered necessary to provide at least £2,000 ($9,733) a year for this purpose, and an appeal was made to the leading shipbuilding and ship-owning firms for yearly contributions to this fund. As a result, at the time of the 1909 meeting of the Institution the sum of £1,240 ($6,035) per year had been subscribed, and this was considered a sufficient guarantee to proceed with the establishment of the tank.

While it is to be regretted that the entire sum necessary to insure the maintenance of the tank for ten years was not forthcoming at the outset, there is little doubt but that before the tank is completed the entire amount will have been subscribed. The past year has been one of extreme hardship in the shipbuilding industry, and funds for any purpose whatever, no matter how worthy, have not been easy to secure. Shipbuilders are by no means blind to the advantages which would accrue not only to themselves individually, but to the engineering profession as a whole, by the establishment of this tank, and we are confident that the project will receive the hearty support it deserves.

Standardizing Shipbuilding Materials.

During the past eight years a great undertaking has been in progress, the size and scope of which has not been generally recognized except by those who were immediately engaged in the work. This work has included the standardization of the size and shape of structural materials and the standardization of tests for such material. It was first proposed by the British Iron Trade Association in 1900, and in 1901 a committee was appointed, consisting of representatives of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Iron and Steel Institute and the Institution of Naval Architects, to carry out this work. Out of this small representative committee, which ultimately became known as the Main Committee on Engineering Standards, has grown an organization embracing thirty-nine various sectional committees and sub-committees, with a total membership of approximately three hundred. Before arriving at any standard, it was first necessary to obtain from the steel makers, merchants, shipbuilders and engineers, and from representatives of various classification societies, evidence regarding the necessity and desirability of retaining various structural shapes then in use; and it was found that radically different sections would be necessary for shipbuilding work, for bridge and building construction, and for railway rolling stock. Committees were, therefore, appointed to deal with each of these classes of material and to so relate the three classes that a joint list could be obtained if possible. The committee which had in charge the standardizing of sectional material for shipbuilding work included representatives of the British Admiralty, the Board of Trade, Lloyds, the Bureau Veritas and the Steel Makers' Association, together with representatives of steel merchants, shipbuilders, etc. It would be impossible to give all the details of the vast amount of work involved in arriving at a standard; but obviously the need for it was very great, as not only was there a wide

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variation in the profiles of similar sections made by the same concerns, but also between professedly similar sections made by different firms. The sections varied both as regards the radii at the roots and corners and also in the proportions of thickness to dimensions.

Some of the more important decisions made by the committee are as follows: it was decided to depart from the practice of tapering the flanges of angle bars and adopt parallel flanges. The thicknesses at which practically correct profiles could be obtained and the range of thickness for each size were specified, and the radii at root and toe were also standardized. Lloyd's sketches for bulb tees, plates and angles were practically adopted, except that it was decided that the standard web should be of the least thickness in proportion to its depth which was consistent with ease in rolling. It was found that the development of channel sections had proceeded entirely in the wrong direction, as it had been customary to keep the flanges at a constant thickness and vary the weight and strength of the bar by adding thickness to the back of the web. In the new standard section the webs are all 2-20 inch less in thickness than the flanges. Zee bars were dealt with in much the same way; but the standardizing of tee sections was left to the bridge committee, as this is a shape seldom used in shipbuilding.

All this work was simply preliminary, leading up to the important point of deciding how many sections should be standardized, a result which could only be obtained by compromise. It was natural that the steel makers should desire to work with the fewest number of sections possible, while, on the other hand, shipbuilders and classification societies wished to have the very fullest range which could be obtained. The final decision arrived at by the committees for shipbuilding, bridge sections and railway rolling stock material resulted in the following number of standard sizes: Equal angles, 16; unequal angles, 30; bulb angles, 20; bulb tees, 6; bulb plates, 7; zee bars, 8; channels, 27; beams, 30; tee bars, 22. The profiles are stated in inches and fractions of inches for the flanges and webs, and in decimals for the thickness.

The standardizing of tests and test pieces was the second important work undertaken, and having accomplished this the committee then took up the question of breaking stresses and elongations, and these figures, while essentially compromises, were made as fairly as possible, taking account of various interests affected. On the whole, this has been a stupendous piece of work, and one which reflects great credit on those who have had it in charge, and who, for the most part, have done their work faithfully and well without any remuneration whatever.

Scout Cruiser Trials.

As yet, very little information has been made public regarding the results of the recent competitive trials of the United States scout cruisers *Salem*, *Birmingham* and *Chester*. The trials were disappointing, in that accidents to both the *Birmingham* and *Salem* marred their performance. The injury to the *Salem* was caused by some foreign substance becoming lodged in the starboard turbine and damaging the blading of the fifth stage. As this, of course, had a decided effect upon the speed and power of the ship, it has been decided to give the *Salem* another set of trials as soon as the damaged turbine has been repaired. Details of the accident to the *Birmingham* have not been made public, but it is reported to have been due to a rupture in the main steam line. This accident occurred on the full-speed trial, which the vessel was forced to discontinue after twelve hours.

The preliminary report just given out by the Navy Department covering the steam and coal consumption of the three vessels during the four series of tests is as follows: For the first test, which was at 10 knots speed for ninety-six hours, the feed-water consumption in tons per day was as follows: *Birmingham*, 10.55; *Chester*, 10.97; *Salem*, 11.66. The coal consumption for this test in tons per day was: *Birmingham*, 31.74; *Chester*, 40.44; *Salem*, 53.85. The second test was at 15 knots speed for fifty hours, with the following results: Feed-water, tons per day, *Birmingham*, 13.9; *Chester*, 13.2; *Salem*, 12.12; coal consumption, tons per day, *Birmingham*, 71.23; *Chester*, 85.62; *Salem*, 107.23. The third test was at 20 knots speed for ninety-eight hours, with the following results: Feed-water, tons per day, *Birmingham*, 26.1; *Chester*, 16.8; *Salem*, 17.51; coal consumption, tons per day, *Birmingham*, 153.47; *Chester*, 157.15; *Salem*, 202.03. The fourth test was at maximum speed for twenty-four hours. The consumption of feed-water in tons per day was for the *Birmingham*, 120.4; the *Chester*, 27; the *Salem*, 45.625. The coal consumption for this latter test was not given, but unofficial reports credit the *Chester* with 417 and the *Salem* with 415 tons per day. The speed of the *Chester* on this test was 25.08 knots, and that of the *Salem*, 24.54. The *Birmingham* discontinued the test after twelve hours, and her speed and coal consumption are not given.

Comparing these figures with those obtained on the preliminary acceptance trials, we find that in the case of the two turbine-driven ships the coal consumption was noticeably higher in the competitive tests than in the acceptance trials, while in the case of the *Birmingham* it was about the same; and whereas both turbine ships showed greater economy in coal consumption than the *Birmingham* on the acceptance trials, the *Birmingham* proved most economical on the competitive trials. Also, on the acceptance trials the steam and coal consumption of both the turbine-driven ships were practically the same, whereas on the competitive trials the *Chester* (Parsons turbines) showed greater economy in both respects than the *Salem* (Curtis turbines). A fair comparison cannot be made, however, until the *Salem* has repeated her trials. This ship is undoubtedly capable of a better performance.

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GEORGE WALLACE MELVILLE.*

Too often the pathway to greatness and fame is marked by the wreckage of competitors, and, even, friends, who have been ruthlessly thrust aside in the egoism of selfish ambition. Thus there may be a grudging admission of ability, but there is no love, no true admiration. When, on the other hand, the hero has always been the helper and friend of his companions, when he has cheerfully acknowledged their aid to his success, then every member of the profession feels that the talent of the helper is reflected on the whole body, and they love the man while they rejoice in his reputation.

George Wallace Melville is such a man. He has been one of the famous men of engineering so long that we find it hard to remember a time when his name was not synonymous, as it is now, with all that represents progress and achievement in our profession. Yet this reputation, as we can now see it, on looking back over his life, seems to have been inevitable from the beginning.

The chief characteristics which have made him great are, in my judgment, indomitable courage and unbounding honesty. It is possible for a man to have great mental ability and yet fail of true greatness if he lack these essentials.

Admiral Melville's Arctic record, which first brought him an honest reputation, where he displayed a heroic courage which has never been surpassed, and for which Congress advanced him a grade in the navy, is well known. This, however, was only a repetition of other instances of absolute fearlessness, beginning with his earliest days in the service. When he became engineer-in-chief, the same courage, but rather on the moral than the physical side, was shown. Beginning with his first annual report, he spoke out fearlessly, setting forth the truth as he saw it, and striving always for advancement and efficiency. Complaint was made to President Cleveland of the plain speech in this first report, but that strong man read it himself and said, "We want more such men."

His courage professionally is also remarkable, and it is not the recklessness of the gambler who will take great risks for a big stake, but the cool, matured determination of the thinker, who has weighed all the chances and believes he is right. Along with this is a faculty which, I believe, is a characteristic of all great men, that, having made his decision, de does not worry about the result. Able men of minor rank are always fearful that something may go wrong and their reputation be injured. The really big man who does things will make some mistakes, but he is strong enough not to dread them. A notable instance of this kind in Melville's career was his use of triple screws for the *Columbia* and *Minneapolis*. Some of his friends, for whose professional opinion he had the highest regard, urged him not to make the experiments, but he had studied the problem carefully, was satisfied of the correctness of the solution, and persevered. The result was, perhaps, the greatest triumph of his professional career.

His ability as an executive was of a very high order. The features of deciding a case and then refraining from worry are evidence of this. He had a rare talent for choosing able assistants, and, having proved them, he left in their hands all of the detail work, thereby giving himself time for the careful study of the larger problems. The effect of this was very marked in stimulating the entire staff to highest efficiency and zeal, and every man counted it a pleasure to work, without regard to hours, for the credit of the "Chief" and the glory of the service.

With respect to his professional work, it is notable that his career as engineer-in-chief is the longest on record—sixteen years. I think this is perhaps the longest service of any bureau chief in the history of the Navy Department. During this time he was responsible for new designs of machinery for about 120 vessels of all classes, twenty-four being battleships and forty-one armored vessels of all kinds. The aggregate horsepower was close to a million and a quarter. Best of all, there were no "lame-ducks" and no failures.

He was the first to use watertube boilers in large war vessels, and when he made one installation he had the courage to resist the temptation for notoriety which would have come from using them generally. He preferred to wait for experience. A famous engineer abroad started later, but went in on a large scale, with much subsequent regret. When the trial period was over, Melville adopted them generally. There was a great temptation when forced draft was adopted to cut boiler weights too low. This was done in one foreign navy with disastrous results. Melville was progressive but conservative, and had no boiler troubles. He was the first to determine the actual coal consumption on trials, with results that were startling to those who had been guessing and projecting the steaming endurance on the guesses. He was also the first to use the method of determining trial speeds, known as "standardizing the screws," which is the simplest, most accurate, fairest to contractor as well as government, and the least expensive.

It is to him also that we owe our first high-speed battleship. When in 1898 the proposals for the *Maine*, *Missouri* and *Ohio* were being prepared, he stood alone in his demand for 18-knot ships. There was some casual opposition and much indifference. If he had not persisted these three ships would have been copies of those designed two years before, and we should have been, for three years longer, behind the other navies of the world in battleship speeds.

During the war with Spain he brought out the repair ship and the distilling ship. The idea of the former was not new, but the *Vulcan* was far the most complete vessel of the kind equipped up to that time. The latter was to furnish fresh-feed water for the boilers, and enable a vessel with a storage bunker capacity of 3,000 tons to supply 60,000 tons of water, the equivalent of about ten ordinary tank ships.

The experimental work carried out under his direction would require a book to give any detailed idea of its magnitude and results, but it must be mentioned that it was all published in his annual reports, so that the profession could have the benefit of it. Almost the last interesting experiments during his administration were an elaborate series of tests of oil fuel, probably the most comprehensive ever made.

My brief sketch of this famous man would be incomplete if I failed to speak of his personality. The lion-like head and the frank speech have led some to say that he is one of the old Vikings spared to us a thousand years after the others have gone. But if this leads any to think that he is harsh and cold there could be no greater mistake. Like all strong natures, he is pronounced in his feelings, but he is a man of warm affection, and when he has once taken you into his heart you are sure of an abiding place there as long as you are worthy. It is often said that no man is great to his intimates, but I have been with him, day by day, for years; have seen him under all conditions, and my admiration and love for him have steadily increased as the years go by. I have no ambition to be a Boswell, and I have not kept notes of his doings; but I have seen the daily workings of a great, kind heart, tender for the humble yet fearless toward the great; and I can truly say that I count it a privilege and an inspiration to have been a trusted friend and helper of this noble man, who has exemplified the highest type of manhood and added new lustre to the profession of engineering.

* Abstract of an address by Walter M. McFarland at the presentation of a portrait of Admiral Melville to the National Gallery, Washington, May, 1909.

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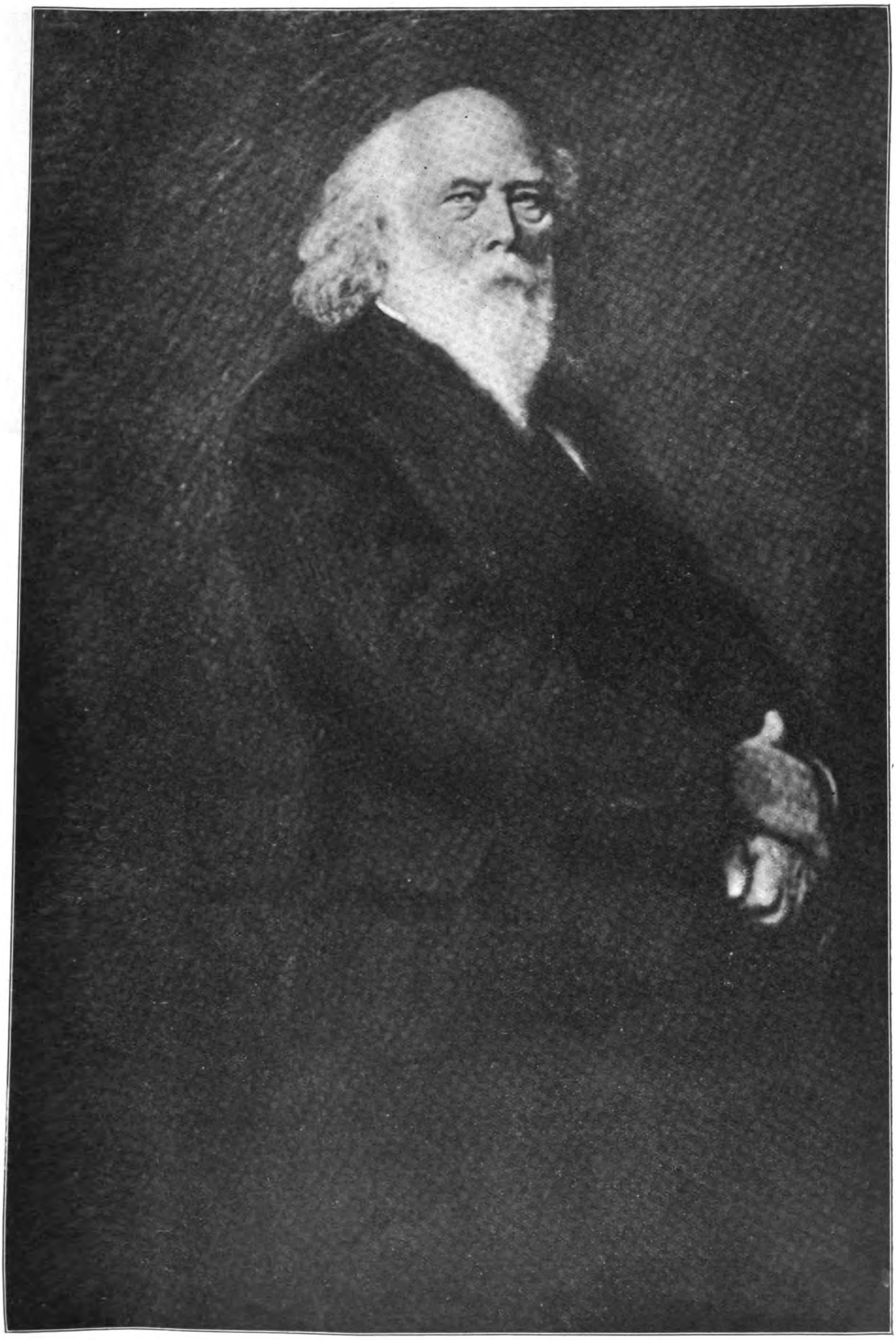

REAR ADMIRAL GEORGE WALLACE MELVILLE.

(From a painting by Sigismond de Ivanowski, presented to the National Gallery, Washington, D. C.)

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Progress of Naval Vessels.

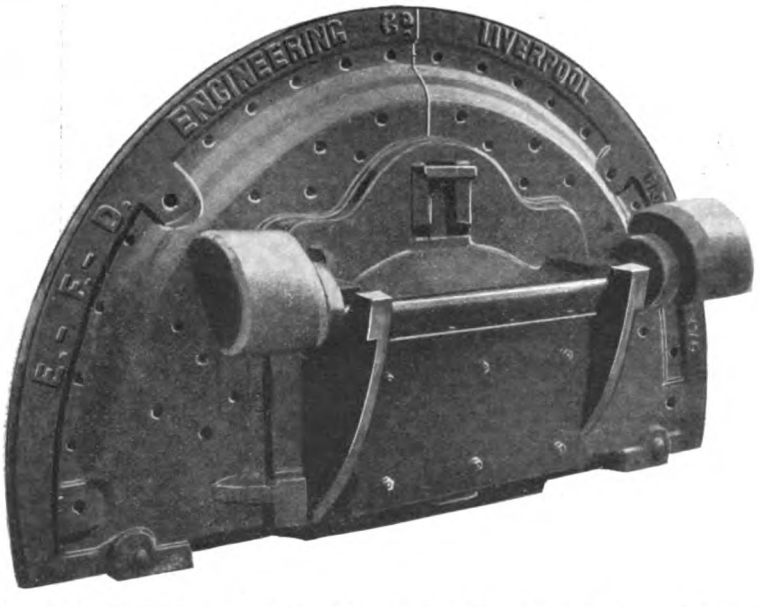
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

	Tons.	Knots.		Apr. 1,	May 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.....	86.9	90.0
Michigan ...	16,000	18½	New York Shipbuilding Co...	95.2	97.4
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	73.0	77.9
North Dakota	20,000	21	Fore River Shipbuilding Co...	77.9	81.5
Florida	20,000	20¾	Navy Yard, New York.....	8.4	11.9
Utah	20,000	20¾	New York Shipbuilding Co...	10.8	14.9
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.....	1 4	81.6
Lamson	700	28	Wm. Cramp & Sons.....	69.4	75.7
Preston	700	28	New York Shipbuilding Co...	64.1	70.7
Flusser	700	28	Bath Iron Works.....	63.2	68.7
Reid	700	28	Bath Iron Works.....	63.0	67.8
Paulding ...	742	29½	Bath Iron Works.....	7.0	9.8
Drayton	742	29½	Bath Iron Works.....	7.0	9.7
Roe	742	29½	Newp't News Shipbuilding Co.	29.5	38.6
Terry	742	29½	Newp't News Shipbuilding Co.	27.4	33.7
Perkins	742	29½	Fore River Shipbuilding Co...	15.7	22.0
Sterrett	742	29½	Fore River Shipbuilding Co...	15.7	22.0
McCall	742	29½	New York Shipbuilding Co...	10.5	11.7
Burrows	742	29½	New York Shipbuilding Co...	10.0	11.3
Warrington..	742	29½	Wm. Cramp & Sons.....	12.4	16.0
Mayrant	742	29½	Wm. Cramp & Sons.....	12.2	16.1
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	82.0	89.8
Tarpon	...	..	Fore River Shipbuilding Co..	81.7	89.7
Bonita	...	..	Fore River Shipbuilding Co..	76.7	81.4
Snapper	...	..	Fore River Shipbuilding Co..	76.3	80.4
Narwhal ...	...	..	Fore River Shipbuilding Co..	84.2	89.7
Grayling ...	...	..	Fore River Shipbuilding Co..	77.8	84.6
Salmon	...	..	Fore River Shipbuilding Co..	66.6	75.3
Seal	...	..	Newp't News Shipbuilding Co.	8.8	12.7

ENGINEERING SPECIALTIES.

The Boltless Improved Boiler Furnace Front.

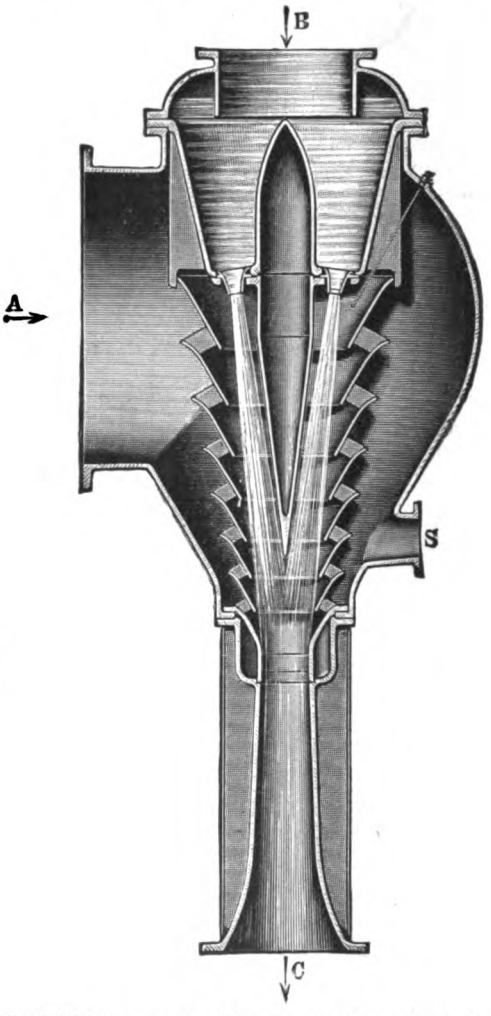
A new patent boltless furnace front has recently been fitted to the boilers of some of the largest steamships in the North Atlantic service, notably the *Adriatic, Baltic, Oceanic* and *Laurentic.* In these furnace fronts the front plate, door frame and flame plates can be assembled in place without tools of any kind. This simplicity of arrangement makes it possible for a laborer or fireman to take down or erect any of



the parts in a few minutes. The front plate is divided vertically, and avoids the use of bolts. This construction removes the liability to failure due to unequal expansion and contraction, as it leaves the front free to expand or contract as the temperature changes. No alteration of the existing arrangements is necessary to apply these frames and doors, as they can be fitted to the ordinary boiler fronts. These furnace fronts, which are suitable for both natural draft and forced draft in closed stokeholds, are manufactured by the "Economical" Forced Draught & Engineering Company, Ltd., 5 Castle street, Liverpool.

The Koerting Multi-Jet Eductor Condenser.

Due to the fact that steam turbines operate more economically when running with high vacua, and also to the fact that the sizes and, consequently, the load factors, of power plants have increased to such an extent that a much larger proportional capital outlay is justified for the auxiliary machinery, more efficient condensing apparatus is necessary than was formerly the case with reciprocating engines, small power plants and small load factors. To meet this demand the Schutte & Koerting Company, Philadelphia, Pa., have placed on the market a multi-jet eductor condenser for installations of 500 horsepower and upwards. This condenser embodies the essential features of the Koerting single-jet eductor condenser, which has been largely used for many years in plants ranging in size up to 500 horsepower. The multi-jet condenser consists, as shown in the illustration, of a number of converging condensing jets, meeting and forming a single jet in the lower part of the condensing tube. The tube is cast in one piece, and consists of a series of concentric nozzles of



gradually diminishing power. The steam flows through the annular passages between the nozzles which guide it, so that it impinges at suitable angles on the condensing jet. The steam, which strikes the condensing jet at high velocity, is condensed, and the particles of water into which it is converted, having the kinetic energy due to the steam velocity, go into the jet and contribute to the momentum needed to discharge this, together with the entrained air and non-condensible gases,

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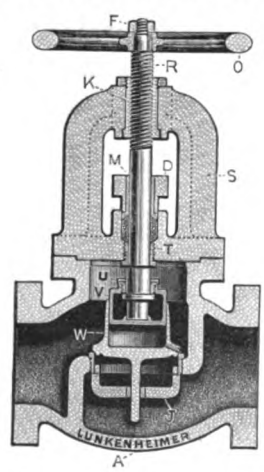
against the resistance of the atmosphere. The condensing tube in vertical section is an inverted cone. In the upper part of the tube the steam is in contact with the coldest water, and condensation is keenest, so that a greater weight of steam is condensed per unit of area of contact than is the case in the lower part of the tube, where the water is hotter. Due to the conical shape of the tube, the sectional area of the steam passages increases from the bottom upwards, thus securing that the sectional area of the ports is proportional to the volume of steam they have to pass. Owing to this the steam velocity is nearly constant from the top to the bottom of the tube, and the drop of vacuum between the interior of the tube and the exhaust chamber can be reduced to a minimum. There must, necessarily, be a higher absolute pressure, or, in other words, lower vacua in the exhaust chamber than in the interior of the tube, as, otherwise, there would be no flow of steam through the ports to the condensing watertubes.

A drop of vacuum equal to ½ inch mercury column, it is claimed, suffices, maintaining 28 inches mercury vacuum, and the actual working vacuum obtained is, therefore, only ½ inch lower than the highest theoretical vacuum, as determined by the discharge temperature and corresponding vaporizing point of the condensing water. It is claimed that with this condenser the ratios of water to weight of steam condensed are, for equal vacua, practically the same as are required for surface condensers. To secure satisfactory working under all conditions of load variation on turbines or engines to which they are attached, it is only necessary to supply the water to the condensers at a pressure at the level of the water inlet flanges equal to 21 feet water column, or, say, 9 pounds per square inch. When, as is usually the case, there is no gravitation supply of water available, it is necessary to use a circulating pump, and, if a motor or belt-driven centrifugal pump be used, the water may be delivered direct into the condensers, or, what is preferable, it may be pumped up into a standpipe to get rid of the air, more or less of which is always contained in the water, and which would naturally influence the vacuum considerably.

From this description it is obvious that the condenser requires no air pumps, has no moving parts, and, consequently, no wear and tear. It is also claimed that it is very simple to operate and requires little space.

The Lunkenheimer Non-Return Boiler Stop Valve.

When several boilers are connected to a common header, it is evident that if a tube is blown out or a fitting ruptured, the steam from the battery of boilers will rush into the header

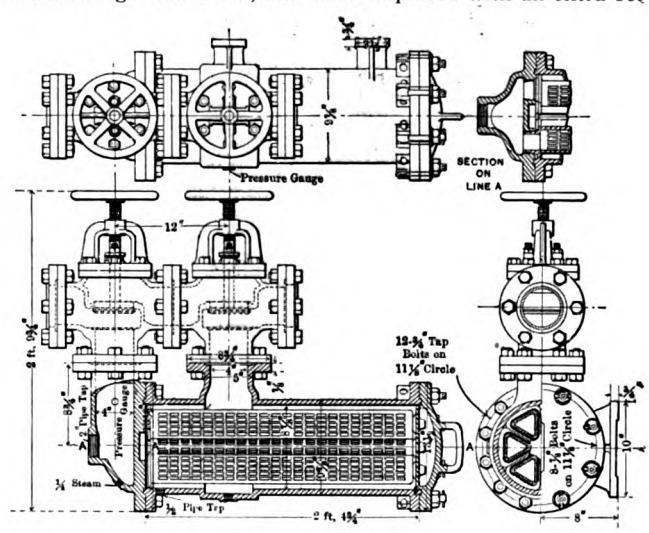


and discharge through the boiler which is disabled. The difficulty of closing a stop valve in the event of such an accident is apparent. The Lunkenheimer Company, Cincinnati, Ohio, has designed a non-return boiler stop valve which is claimed to entirely overcome this danger. This valve is intended to be placed between the boiler and header. It prevents steam being turned into it when it has been cut out for cleaning or repairs, for the reason that the valve cannot be opened by hand. It can, however, be closed by hand the same as any other stop valve.

The company states that these non-return valves are made only of the best materials, and that the areas are unusually large and free. The internal dashpot and piston prevent chattering of the disc. All wearing parts are made of bronze, and the gland and stuffing box are bronze bushed. For use with superheated steam these valves are made of puddled semi-steel, with nickel trimmings and nickel-steel stems. The valves are made in sizes from 4 to 10 inches, inclusive, and can be furnished with screw or flange ends.

A Feed-Water Grease Extractor.

The illustration shows a new feed-water grease extractor, manufactured by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. Two valves forming the inlet and discharge from the extractor, when seated as shown in the drawing, force the water into the shell of the extractor through the cartridges, and, in this manner, the grease is extracted. When the valves are seated on the lower seat, they form a by-pass, so that the shell of the extractor can be opened, the cartridges taken out, and either replaced with an extra set



or cleaned and put back. The ratio of the openings in the cartridges to the inlet of the extractor is 48 to 1. The cartridges are held firmly in place by seating in the base, and by plate and spring washers at the top. The pressure gages are applied to both the main chamber and base, so as to note the difference in pressure and tell when the pressure in the main casing is increased, due to the restricted flow of the water by the covering of the cartridges becoming filled with grease. Provision is also made in the base to connect a ¼-inch steam pipe, driving steam into the inside of the cartridges, and in this manner cleaning them, so as not to necessitate taking the cartridges out as often as would otherwise be necessary. The shell of the extractor is small and the cartridges are triangular.

The Bergesen Automatic Steering Engine.

Most steering engines are so constructed that when the rudder is moved only 2 or 3 inches the steering engine makes from ten to fifteen revolutions, and each of the cylinders is filled with high-pressure steam from ten to twenty times. This involves, of course, a great number of rapidly-moving parts, requiring constant readjustment, careful oiling and skilled attention.

A new steering engine has recently been placed on the

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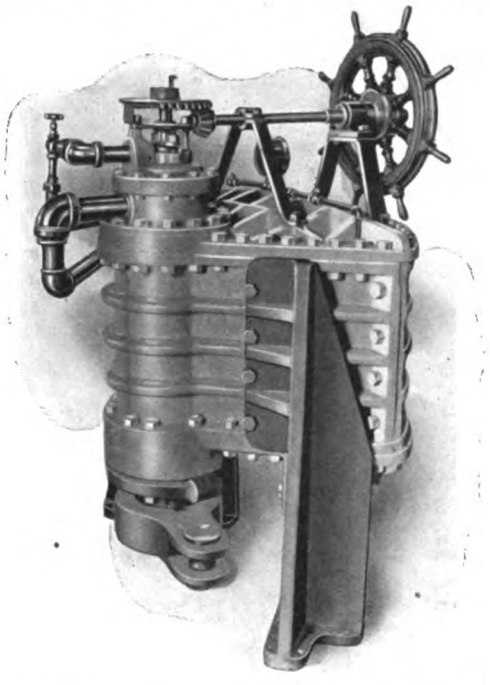
market, known as the Bergesen direct automatic steering engine, manufactured by the Bergesen Manufacturing Company, 74 Broadway, New York, in which for a corresponding movement of the rudder the piston moves only from ½ to 1 inch from its middle position, and only sufficient steam at low pressure is admitted on one side of the piston to secure the small amount of movement in the piston and rudder, consequently the engine performs its work noiselessly. It is also claimed that putting the rudder hard over to either side while the ship is under full headway is performed noiselessly.

The piston and piston rod of the engine are of one piece of steel, being about eight times the strength of the old construction of securing pistons to piston rods. There are no eccentric rods, eccentrics or sliding valve stems. One oscillating valve stem and valve controls all the movements of the engine. A special style of piston packing is used, which, it is claimed, takes up its own wear and lasts for a very long time. It is also claimed that the valve in the Bergesen engine takes

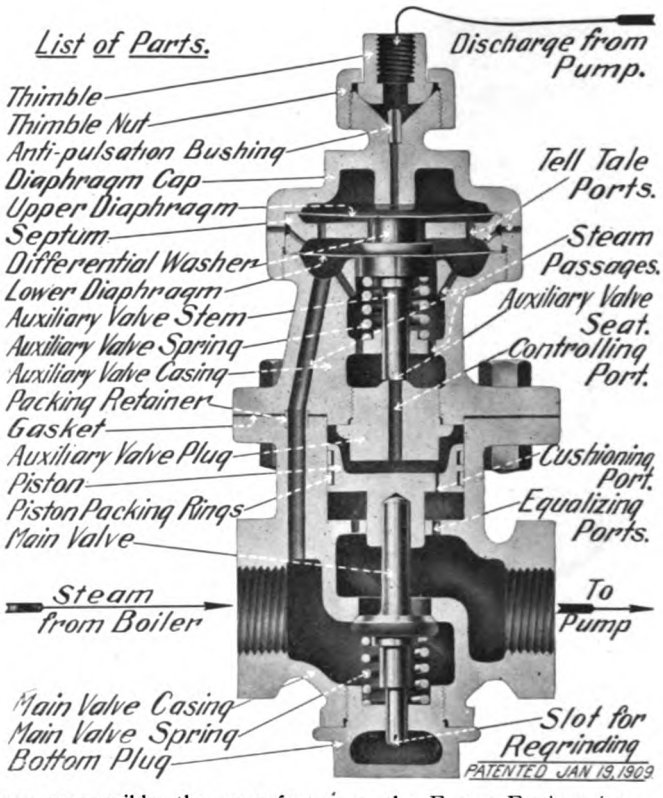


up its own wear, as the pressure on the valve holds it on its two seats, so that it remains steam-tight. No gaskets or joint material are used in assembling the engine, consequently there are no joints to blow out or renew. There is not a single bolt, nut or washer of any sort in the cylinder, piston or steam chest. The joints are all carefully made by scraping and grinding to a steam-tight fit, metallic packing being used on the piston and valve-stem rods. The limits of oscillation of the valve-stem lever are adjustable, so as to control the movement of the rudder and stop it just before it arrives at the hard-over point on either side. The movement of the rudder is the same as that of the lever on the valve stem or from zero to 45 degrees on either side, so that if a lever is used in the pilot house, or on the bridge in place of a wheel, the position of the lever indicates the position of the rudder. Transmission from the bridge or pilot-house to the valve and engine can be made through shafts and gears, ropes, chains or rods and bell cranks.

This steering engine is suitable for use on all types of vessels, from the largest ocean liners and warships down to the smallest river steamers, yachts, tugs, motor boats and launches.

The Foster Excess Pump Governor.

This pump governor was fully described on page 199 of our May issue, but, due to a mistake, for which we were in no



way responsible, the manufacturers, the Foster Engineering Company, of Newark, N. J., sent us an engraving showing a sectional view of their class U pressure regulator, which was used as an illustration of the pump governor. We publish herewith a sectional view of the excess pump governor; for details of which see page 199 of our May issue.

TECHNICAL PUBLICATIONS.

The Engineering Index Annual for 1908. Size, 6½ by 9 inches. Pages, 437. New York and London, 1909: *The Engineering Magazine.* Price, $2.

From the years 1884 to 1891, *The Engineering Index* was published by the Association of Engineering Societies, under the direction of Professor J. B. Johnson. From 1892 to 1895, the *Index* was edited by the Association of Engineering Societies, under the direction of Professor Johnson and published by *The Engineering Magazine.* Since 1896 the book has been both edited and published by *The Engineering Magazine.* The present work comprises the seventh volume, and includes classified lists of the most important articles published in the technical press during the year. Each article is briefly described, and information is given regarding the issue of the publication in which it appeared. In the 1908 volume, 8,248 articles are indexed, exclusive of cross-references, as compared with 7,848 in the 1907 volume. This gain in range has been obtained without material increase in the size of the book, as more careful attention has been given to conciseness in writing the descriptive legends.

Resistance and Propulsion of Ships. By Prof. William F. Durand. Size, 6 by 9 inches. Pages, 427. Figures, 109. New York, 1909: John Wiley & Sons. Price, $5.

This is the second edition of a book which, for the past ten years, has been one of the standard treatises on the subject of resistance and propulsion of ships. The scope and contents of this book are so well known by marine engineers and naval architects that little need be said regarding the general treatment of the subject. It is inevitable that progress should be made during the course of time on any subject in which there is opportunity for such extended research, as is the case

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with the resistance and propulsion of ships. Development is bound to come also, from the further fact that the increased number of ships built furnishes additional data to the designer and engineer. Since the first edition was published, the chief contributions to the material available for the discussion of this subject have consisted chiefly of results of various experimental researches, the most important of these relating to the screw propeller. In the present volume, reference has been made to some of the more important recent contributions to general theory, although no attempt has been made to change the general character of the theoretical and descriptive treatment of the subject. An effort has also been made to summarize some of the more important researches which have been the results of experience, and this has been included. The book has not been increased in size, since the additional matter has simply taken the place of other matter of relatively minor importance which has been omitted.

Flag Sheet. Size, 35 by 32½ inches. Illustrations, over 400. *Liverpool Journal of Commerce.* Liverpool, 1909. Price, paper, 1s; framed and varnished, 2/6; framed and glazed, 3/6.

The "Flag Sheet" comprises over 400 illustrations of the various types of flags at present in use, and includes excellent pictures of the various ship companies' flags, international code flags, and the flags of sailing vessels, government boats and those in the international mercantile service. The chart constitutes a very fine permanent reference to all the insignia which are met on the high seas.

Tables of Properties of Steam and Other Vapors and Temperature Entropy Table. By Prof. Cecil H. Peabody. Size, 5¾ by 9 inches. Pages, 133. New York, 1909: John Wiley & Sons. Price, $1 (4/6).

The properties of steam have recently been redetermined by new and refined methods that are capable of great certainty and precision, so that computations based upon them show a satisfactory concordance. These tables, which were first published twenty years ago, and revised in 1907, have, therefore, been recomputed, basing the computations upon this information. The book includes tables of the properties of steam, and a temperature entropy table, giving solutions of all the adiabatic problems, both for saturated and for superheated steam. The methods of computation are explained in the introduction, and the steam tables are followed by tables of Naperian and common logarithms.

Internal Combustion Engines. By H. E. Wimperis. Size, 5½ by 8½ inches. Pages, 326. Figures, 114. New York, 1909: D. Van Nostrand Company. Price, $3 net.

Text-books dealing exclusively with the subject of the internal combustion engine are, by no means, as plentiful as those dealing with the steam engine, yet the growing importance of the internal combustion engine obviously creates a need for such books. The development of the internal combustion engine has been so rapid that the subject now demands individual and exclusive attention. This book is divided into three sections, the first dealing with the theory, and including chapters on the thermodynamic cycles, combustion and expansion and thermodynamics. The second section takes up gas engines and gas producers, the first chapter treating of the engine, the second of the producer, and the third of blast furnace and coke-oven gases. Section three is devoted to the oil and petrol (gasoline) engines, and includes two chapters, the first describing various types of engines and their method of working, and the second petrol (gasoline) engine efficiency and rating. To the marine engineer the portion of the book dealing with gas engines and gas producers will undoubtedly be of most interest; for it is only by the use of producer gas that large installations of gas engines can be made on board ship, the cost of fuel with oil and petrol (gasoline) engines being prohibitive, except for small installations, such as are used in motor boats.

COMMUNICATIONS.

Regarding the Indomitable.

Editor INTERNATIONAL MARINE ENGINEERING:

With reference to some statements made in regard to the *Indomitable* on page 6 in your January issue, permit me to state that:

1. The speed of this ship is as great as it has ever been.
2. The turbines are in perfect order and have not been touched by any dockyard since acceptance.

CHATHAM, April, 1909. H. KING HALL,
Captain, H. M. S. *Indomitable.*

Explosion on Board the Foca.

Editor INTERNATIONAL MARINE ENGINEERING:

Following is a brief account of the sad accident which occurred on board the Italian submarine torpedo boat *Foca,* described on page 109 of your March, 1909, issue.

The *Foca* was taking on a supply of petrol (gasoline) in the inner side of the military harbor of Naples on a very hot day, when there was no breeze, and, consequently, the atmosphere was absolutely still. Under these circumstances a certain quantity of the gases from the petrol (gasoline), which are heavier than the air, entered the light superstructure, which is set above the resistant hull of the boat, and which forms the deck. Unfortunately this danger had not been foreseen, and no means had been provided to secure the proper ventilation of the superstructure. A spark or some other form of ignition caused the explosion which destroyed the light superstructure, where all hands were collected, but the resistant hull and the inside of the boat were left absolutely unharmed. The tanks of benzine were found to be completely filled after the explosion, and the machinery, etc., was in complete order.

"B."

PERSONAL.

LIEUTENANT COMMANDER HUTCH I. CONE has recently been appointed Chief of the Bureau of Steam Engineering of the United States Navy, with the rank of Rear Admiral. Lieutenant Commander Cone was chief engineer of the battleship fleet during its cruise around the world.

NATHAN PRATT TOWNE, chief engineer of the William Cramp Ship & Engine Building Company, Philadelphia, Pa., and formerly an engineer in the United States Navy, died April 23, aged 65 years. Since 1893 he designed and superintended the construction of the engines of nearly all the battleships, cruisers and large vessels built at the Cramp shipyard.

ALEXANDER MILLER, head of the firm of Alexander Miller & Brothers, of Jersey City, N. J., died at his home in that city May 6. Mr. Miller was born in Aberdeen 65 years ago, and came to America at an early age. His first engineering experience was with the old Delamater Iron Works of Jersey City. Later he was connected with the Deeley Iron Works.

SIR DONALD CURRIE, head of the shipowning firm of Donald Currie & Company, died April 13. When a young man he was connected with the Cunard Line, working in Havre and Liverpool. He founded the original Castle Line, running between Great Britain and India, and later he established the Castle Line to South Africa, which, since merging with the Union Line, now has a fleet of more than fifty vessels, aggregating about 325,000 tons. Sir Donald was knighted in 1881, and was a member of Parliament from 1880 to 1890.

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SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

912,291. ELECTRIC LOG. JOHN H. CUNTZ, OF HOBOKEN, N. J.

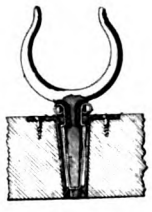
Claim 2.—The combination with a propelling member of a log, of a flexible shaft, an electric generator, means for steadying the speed of the rotating generator including a torsional shaft, a plurality of indicators and conductors from the generator to said plurality of indicators. Four claims.

913,372. MEANS FOR SIGNALING OR EFFECTING OPERATIONS BY MEANS OF SOUND VIBRATIONS. JOHN GARDNER, OF KNOTT END, NEAR FLEETWOOD.

Claim 2.—Sound signaling apparatus comprising in combination a sound-receiving transmitter, a telephonic receiver in circuit therewith, a tunable diaphragm therefor, microphonic contacts upon and operable by said diaphragm and in a normally closed electric circuit, a device included in said circuit and having a movable part which moves when the contacts are vibrated and the current is consequently reduced, a local electric circuit, and a signaling instrument contained in said local circuit, such local circuit being controlled by the said movable part to affect the signaling instrument upon and during the persistence of the microphonic vibrations. Five claims.

913,457. OAR-LOCK. CHARLES BESTMAN, OF FRIDAY HARBOR, WASH.

Claim 1.—In a device, a keeper having a constricted opening, an oar lock consisting of a yoke and a tapered stem for engaging the keeper



having oppositely arranged longitudinal grooves, and spring members in the grooves provided with off-set portions for engaging the constricted opening. Two claims.

913,617. RING BUOY. HERMAN F. BUSCH, OF MILLVALE, PA., ASSIGNOR TO ARMSTRONG CORK COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.

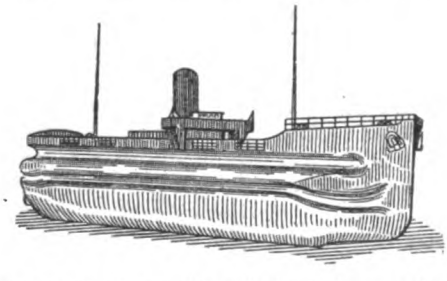
Claim 1.—A ring buoy comprising an annular-body portion of uncovered buoyant material, a peripheral metallic band surrounding the body portion and a plurality of transversely encircling bands. Four claims.

913,951. PROPELLER. FRED. J. GOWING, OF SACKET HARBOR, N. Y., ASSIGNOR OF ONE-HALF TO JEROME B. ROSEBOOM, OF NOGALES, ARIZONA TERRITORY.

Claim.—A two-blade propeller, comprising a central hub, and a pair of oppositely disposed concaved blades, the said blades having a long, straight cutting edge extending at right angles to and flush or in the same plane with one end of said hub, and having a width greater than the length of said hub for a distance equal to the length of said cutting edges, the concavity of said blades gradually increasing from at or near the tips thereof to the points where they are joined to the hub. One claim.

913,973. NAVIGABLE VESSEL. WILLIAM PETERSEN, OF GOSFORTH, ENGLAND, ASSIGNOR TO THE MONITOR SHIPPING CORPORATION COMPANY, LTD., OF NEWCASTLE-UPON-TYNE.

Claim 1.—A vessel having its sides recessed, with a groove extending over the greater part of the vessel's length with a vertical breadth measured parallel to the frame, approximately four or five times greater than the depth of groove measured at right angles to the frame, such



groove being practically parallel with the load water line, and being below the water line, and having the upper and lower edges of practically similar radii merging into the normal contour of the submerged vessel above and below such groove. Eight claims.

914,230. SHIP-VENTILATOR AND CONNECTIONS THERETO. EDWIN ORLANDO BLACKWELL, OF WYNYARD, TASMANIA, AUSTRALIA.

Claim 7.—The combination of decks having openings of different sizes therein, said openings being in line with each other, ventilator tubing having sections of different sizes secured to said decks around said openings, an opening being left around the top of each tube except the highest one, movable plates for closing said openings, means for moving said plates, and stops to limit the upward movement of said plates. Twelve claims.

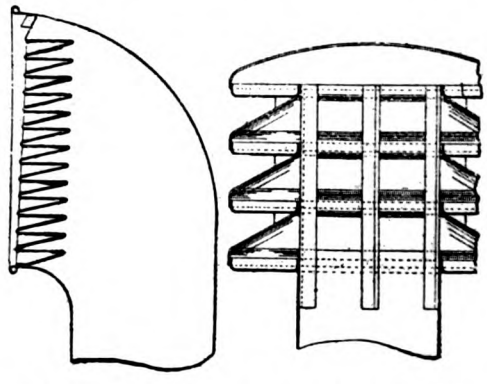
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

22,139. OPTICAL INSTRUMENTS. F. C. SHIPP AND G. HONEYBALL, IPSWICH.

A peep-tube for enabling an object to be distinctly seen in foggy weather without looking in a direct line comprises a long telescopic or other tube provided at the end directed towards the object with a source of light, and at the other end with an inclined mirror in which the reflection of the object is seen by the observer. A glass may be fitted to prevent fog from passing through the tube, which is attached by hooks, etc., to the ship, vehicle, etc., upon which it is used. If desired, the tube may be jointed, intermediate mirrors and lenses being provided at the joints.

22,366. VENTILATION. W. R. LAWSON, TOTTENHAM, MIDDLESEX.

Ships' ventilators are provided with fixed louvres carrying horizontal perforated plates which arrest the passage of rain and sparks. In the



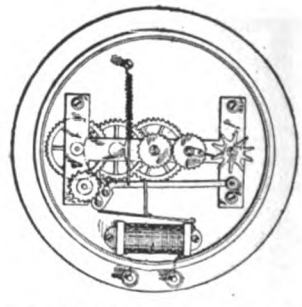
turret type of ventilator the circular louvres and the channel-section perforated plates are riveted to angle-irons which slide in the lower pipe.

22,423. LAMPS. L. C. H. R. EILBERTSEN, NEWCASTLE-ON-TYNE.

Signal lamps are constructed so as to signal to a ship's officer whether or not the rudder has been turned to the position desired. The lamp comprises an outer casing, which is provided with two vertical slots, and is connected by lugs or stays to a fixed part of the steering gear. Within the outer casing revolves a frame fitted on the sides with two sets of alternate green and red glasses, parts of the glasses being obscured. When the rudder is parallel to the keel no light is shown, but the frame is fixed to the steering gear by means of a projecting spindle, and, when the rudder is turned, the red or green lights are brought opposite to the two slots in the outer casing, and two red or green lights are seen, according to the direction in which the rudder is turned, and the area of light seen depends on the extent of the turn.

22,473. SHIPS' LOGS. E. V. H. RIZZO, WESTMINSTER.

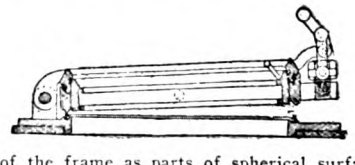
Relates to an improvement upon an electric ship's log. The armature of the electro-magnet when attracted puts tension on a spring which, when the circuit is broken, actuates the registering mechanism. This



mechanism consists of a train of geared-down wheels with hands attached to the spindles of wheels, which indicate tenths of knots, knots and hundreds of knots, respectively. The make and break is actuated by a rolling mechanism bearing on the disk, which has a conducting sector.

23,132. SHIPS' CABIN LIGHTS. W. T. M. FOGGIN, MORPETH, NORTHUMBERLAND.

Cabin and deck lights, of the type wherein the glass-containng frame is rotatable about a diametric axis on pins and is provided with a hinged locking ring, are constructed with the inner face of the locking ring



and outer face of the frame as parts of spherical surfaces. A special toggle lever fastening is provided, which allows sufficient movement of the ring to enable the frame to rotate. The glass frame may be mounted in a swinging frame, with rubber rings between the bearing surface, or the frame may be mounted in a fixed frame.

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